МЕТАЛЛУРГ

METALLURGIST

(METALLURG)

IN ENGLISH TRANSLATION

1957

NO. 10

CONSULTANTS BUREAU, INC.

227 WEST 17TH STREET, NEW YORK 11, N. Y.

an agency for the interpretation of international knowledge

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Monthly Industrial Technical Journal
of the Ministry of Iron and Steel
of the USSR

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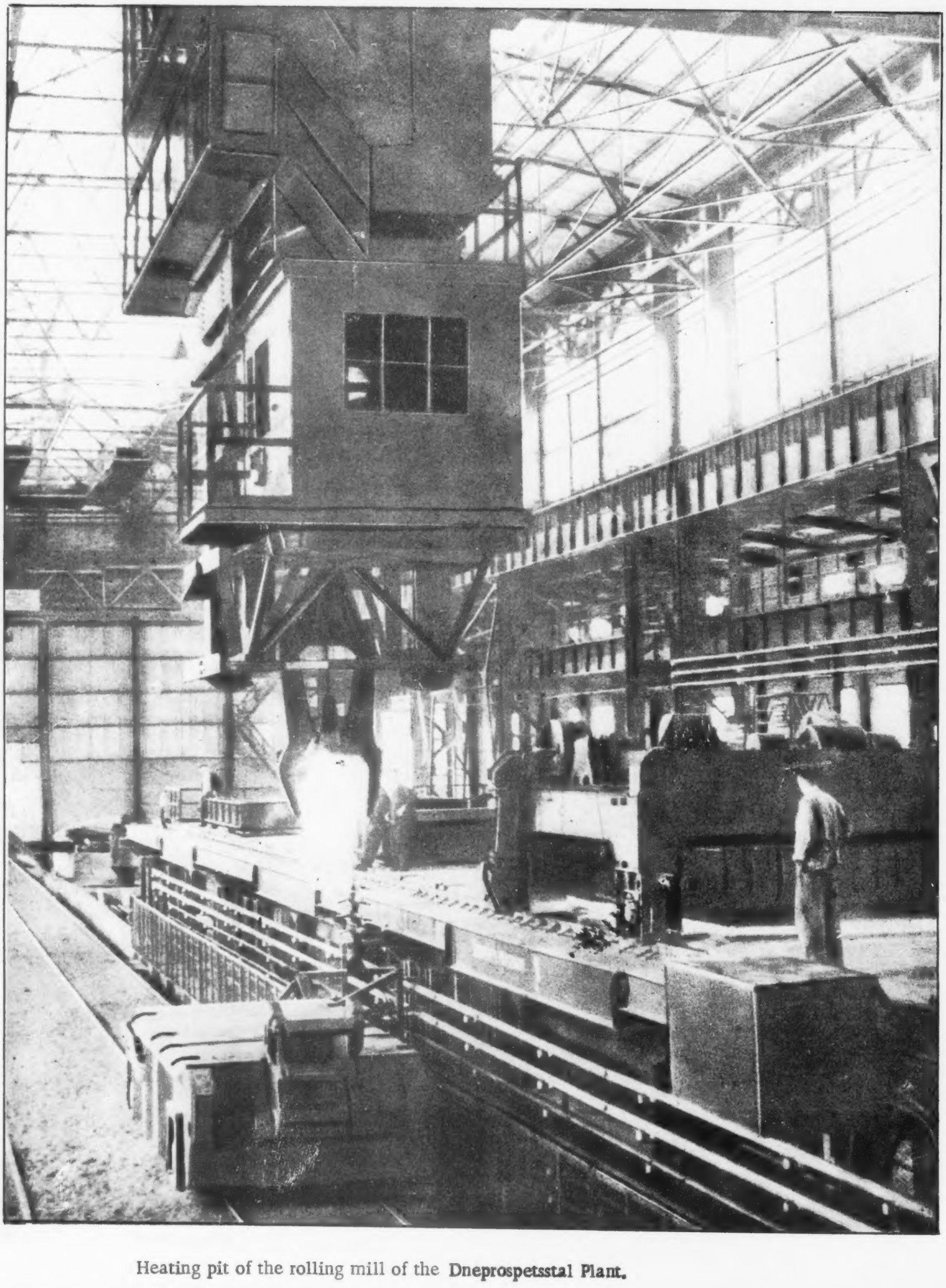
CONSULTANTS BUREAU, INC.
227 West 17th Street
New York 11, N.Y.

Printed in the United States

Annual subscription $95.00
Single Issue $20.00



Heating pit of the rolling mill of the **Dneprospetsstal Plant.**

25TH ANNIVERSARY OF DNEPROSPETSSTAL

G. M. Borodulin
Chief Plant Engineer

The pioneer of electrometallurgy in the Ukraine is the Dneprospetsstal plant which, like many of the Socialist undertakings of our country – Dneprogess, the Magnitogorsk and Kuznetsk iron and steel plants and the Kharkov and Stalingrad tractor plants – were built during the years of the first Five-Year Plan.

At a distance of about ten kilometers from the former small county town of Aleksandrovsk, since renamed Zaporozhe, the building of gigantic industrial undertakings was begun on the banks of the Dnepr.

Shop after shop and plant after plant grew up in the industrial area.

The first electric furnace at the high-grade steel plant went into operation on the 10th October, 1932. At 4:40 p.m. metal flowed from the furnace through the tapping spout into the ladle. Mikhail Ivanovich Kalinin and Sergo Ordzhonikidze were present at the tapping of the first heat. They warmly congratulated the collective of builders and wished the electric steelmakers further success. This day is regarded as the birthday of the Zaporozhe electrometallurgical plant for the production of high-grade steels.

Production at the plant grew from year to year. In 1940, output of electric steel was 780% greater than in 1933. The production of rolled products had increased still more. The total output of rolled products in 1933 was 9.3 million rubles while, in 1940, it was 164.5 million rubles.

Prior to the Great Patriotic War (Second World War), our plant was one of the main suppliers of high-grade tool and structural steels for the foremost producers of our country.

The treacherous attack of fascist Germany on the Soviet Union disturbed the peaceful labors at Zaporozhe. From 18th August, 1941 when the enemy reached the Dnepr, work at the plant was stopped.

In the short lulls between the firing of enemy guns, basic items of plant equipment were dismantled and dispatched to the East. A great part of this equipment and the most experienced personnel were evacuated to the Kemerovo region to the town of Stalinsk. Here, at the Kuznetsk iron and steel combine, new shops were built in quick time and the plant began to produce metal.

The new life of the plant on liberated Ukrainian soil began again in 1948 when the second steel melting shop was restored (or, to be more exact, was rebuilt) on the ruins and ashes left behind by the German plunderers. On the 26th October, 1948, furnace No. 2 produced the first heat.

The restoration of the plant continued. New shops and units were built which had not existed before the war. The plant was also better equipped than it had been prior to the war.

Basic equipment at the plant – electric furnaces, rolling mills, forging hammers, heat treatment furnaces – was better designed and of higher productivity than before the war.

The capacity of the plant is several times higher than it was prewar.

Only during the fifth Five-Year Plan and during 1956 did the plant produce above the norm to the extent of 73,500 tons of high alloy electric steel and about 32,500 tons of rolled products. From 1951 to 1956 alone, inclusive of the year 1956, the plant exceeded planned production by more than 115 million rubles. All the main shops successfully fulfilled the State plan.

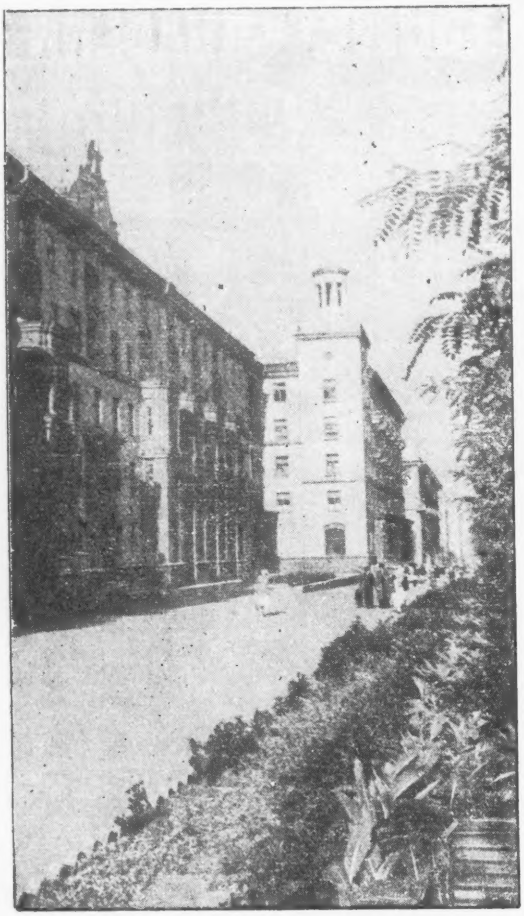


Fig. 1. Apartments belonging to the plant on Lenin Avenue.

From year to year, the technical and economic operational indices are also being improved. In the fifth Five-Year Plan alone the annual reduction in comparative production costs in relation to the previous year was from 7.9 to 24.6%. In 1955, the productivity of labor, compared with 1951, had almost doubled.

There was a marked reduction in raw materials and electric power consumption compared with 1940. There was a 1.7 times reduction in the consumption of electrodes per ton of metal overall. In the first-steel-making shop, the consumption of electric power was reduced 1.3 times. In the same shop, the amount of rejects was reduced by over two-thirds.

In one of the steel melting shops current stoppages of electric furnaces are now reduced, compared with those of 1940, by 75% and constitute 7.2% of furnace operational time. The amount of steel tapped per 1000 kva of transformer capacity in this shop has been increased by 44% on furnace No. 1 and by 31% on furnace No. 2.

In the postwar period, much work has been done to perfect technology and introduce new techniques.

Oxygen has been widely used, we have mastered the vacuum treatment of liquid steel in the ladle and during pouring, we have intensified metal heating processes prior to rolling and forging and have increased the amount of reduction in rolling mills.

Much attention has been paid at the plant to the mechanization and automation of production processes. Work in steel melting shops and rolling mills has been mechanized to a considerable degree. Since 1956, much work has been done on the mechanization of forging processes. In the present day forge, manipulators are used on all 5-ton hammers for forging ingots and metal is removed by automatic "harvesters".

More than 500 different measures have been taken at the plant during the last two years – all directed at perfecting production, mechanization and automation of processes. We are constantly introducing new techniques and the latest technology into production and improving labor and safety conditions.

In 1957 alone, in accordance with the agreed plan, 149 different measures will be introduced in relation to new techniques and technology, mechanization of production and reconstruction of existing equipment.

There have been great developments in the utilization of inventions and innovations at the plant. In the last six years alone, more than 4300 suggestions have been put forward and these have led to a saving of 11.6 million rubles when applied to production.

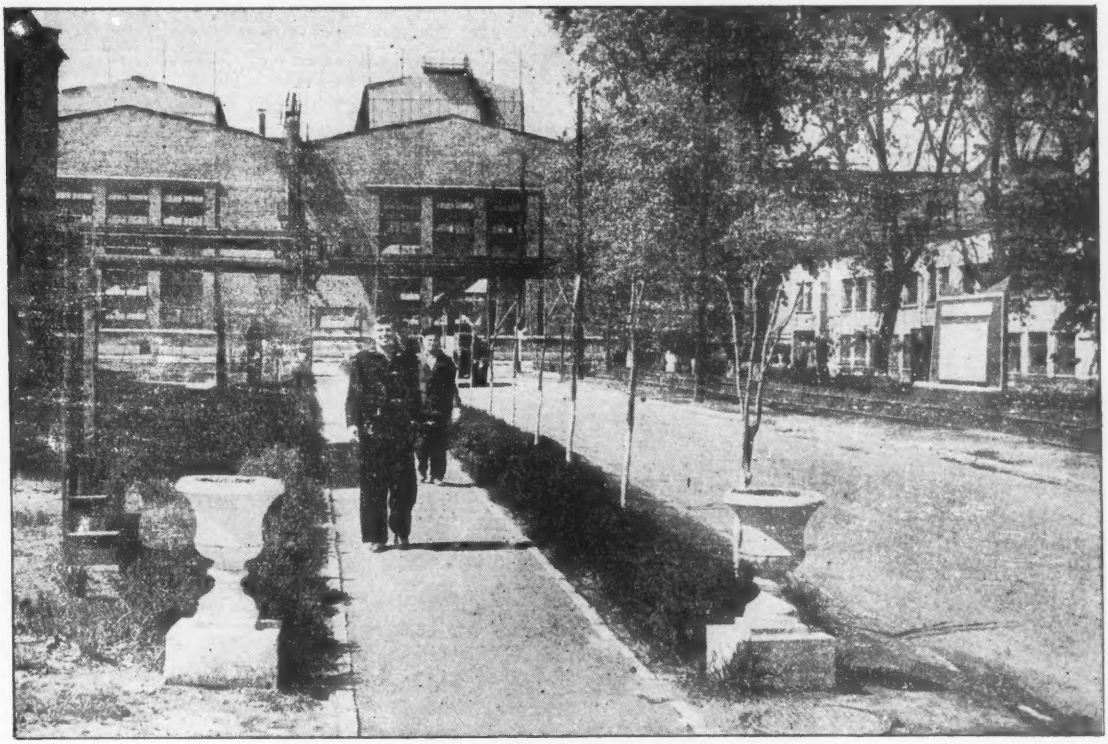
At present, the plant workers are competing for the great meeting of the fortieth anniversary of the Great October Revolution.

The plant collective took on itself the responsibility of producing 10,000 tons of steel and rolled products over and above the norm by the end of the year.

Utilizing reserves of production, the working men and women, the foremen, engineers, and technicians and the office workers are successfully fulfilling their obligations. We have already produced thousands of tons of metal over and above the plan.

PIONEER OF UKRAINIAN ELECTROMETALLURGY

In 1928 when work began on equipping the Dneprogess dam (reservoir), there was signed the decree of the Soviet of Peoples' Commissars regarding the construction of the Dneprovsk industrial combine – one of the largest in Europe.



The rolling mill.

In prerevolutionary Russia, there were no plants for producing high grade steel. The Dneprovsk plants had to increase considerably the production of high grade steels in our country.

On the 10th October, 1932, a government commission took over the exploitation of the Dneprovsk hydro-electric station. It adopted the name of V.I. Lenin. On the same day, at 4:40 p.m. a blinding stream of metal rushed out of the taphole of the electric furnace as the first heat was tapped.

Thus was born the first steelmaking shop of the tool steel plant now known as Dneprospetsstal, the first special steels plant in the Ukraine. The rolling mill consisting of a 750 mm roughing stand and 450, 360 and 280 section mills, commenced operations in 1933. In 1934, fourteen forging hammers began work and the heat treatment plant was completed.

The end of 1935 saw the beginning of the construction of a second steel melting shop based on the duplex process: Zaporozhstal open hearth furnaces and No. 2 shop electric furnaces.

At the end of 1939, the Zaporozhstal combine was subdivided. Our plant was made into a separate independent economic unit.

In 1935, the plant exceeded the planned capacity while, in 1939, it was producing two and a half times as much as was provided for in the old plan.

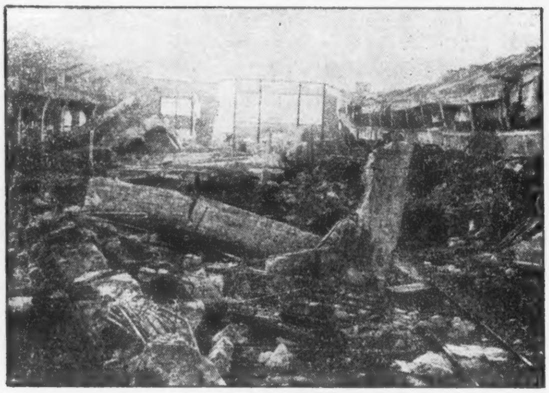
Before the war, more than 100 grades of steel were melted at the plant: stainless, heat-resisting, high speed , ball bearing grades, etc.

Throughout our entire country, it was scarcely possible to find a corner where people had not heard of Dneprospetsstal steels.

The Hitlerite invasion destroyed the peaceful creative labor of the Soviet peoples. When the front approached, the evacuation of the plant began. In ten days, the basic equipment was removed and evacuated with the first echelons and the remaining equipment was dispatched during the next fifteen days. The plant was resettled in Stalinsk. Here, during the course of several months, the electric furnaces and rolling mills sent from Zaporozhe were assembled. After one years' operations, the productivity of all units of the "Spetsstal" Plant (as the plant came to be called in Stalinsk) was, on the average, doubled. Steel production exceeded the level previously attained in the South. Thus, the "Spetsstal" Plant collective played its part in the struggle against the usurpers.

After victory over the Hitlerites, there began the restoration of the plant from the heap of ruins which remained.

In 1948, powerful metallurgical shops with highly mechanized and automated units were installed and exploited. Prior to the war, charging machines were used for charging electric furnaces but the furnaces are now bucket charged and are of the run-out-body swing roof type. Charging which formerly took 40 to 60 minutes now takes 3 to 5 minutes. There is no time for the furnace to cool off, melt-down time is cut and consumption of electric power is reduced.



Here was the old rolling mill.

The electric furnaces can rotate through 37° around their axis in both directions from the normal position. This greatly facilitates pulling the charge from the banks and prevents the formation of "bridges" during melt-down while also prolonging bottom life in large furnaces. The furnace body can be run out onto the working platform or the roof can be swung aside over the pouring bay and this considerably reduces down time for hot repairs.

The third steelmaking shop, which did not exist at the plant before the war, is equipped with 40-ton furnaces and is the largest electric steelmaking shop in the U.S.S.R. The rolling and forging shops of the plant are the largest of any in special steel plants.

The friendly collective of the plant are striving to introduce the latest techniques and technology and to increase productivity without introducing additional units of plant.

In 1955, the plant, in cooperation with the U.S.S.R. Academy of Sciences Institute of Metallurgy, developed a design for the first industrial unit in the U.S.S.R. for vacuum treatment of electric steel in the ladle before teeming. The operation of this plant has attracted the attention of a number of plants and research institutes.

The oxygen nozzle installed in the furnace roof, electric arc and gas heating of hot tops, modernization of electric arc furnaces, reconstruction of rolling mills, the setting up of plant schools for studying the latest techniques, the issue of pamphlets, placards and bulletins to exchange experience, reports and lectures – all these by no means constitute the full schedule of technical and social measures which enabled steel production in 1956 to be increased by 17.1% and the output of rolled products by 8.2% compared with 1955. Overall production was 14% higher. The year 1956 saw a saving of almost ten million rubles due to lowered costs. The plant produced 220 different grades of steel.

In 1940, a single operative had 40.8 kwh of electric power at his disposal but in 1956 he had 70.8 kwh available. Over a thousand consumers manufactured articles from our steels in 1956. We also ship our products to the countries of the peoples' democracies.

Dneprospetsstal lives intensely and each year it gives more metal to our native country.

S.A. Leibenzon

25TH ANNIVERSARY OF THE DNEPROSPETSSTAL WORKS

IMPROVEMENT OF PRODUCTION METHODS AND NEW TECHNOLOGY

V. G. Speransky

Head of the Technical Department

Our workers continually increase the production of high-grade metal. New methods and advanced technology are systematically introduced in the Works. It is difficult to describe in one article all the improvements put into practice in our Works and we shall deal here only with the most important ones.

The adoption of vacuum treatment of liquid metal in the ladle prior to teeming constituted the most effective measure for the improvement of transformer steel quality. More than 15,000 tons of steel was vacuum treated; hence the improvement in the electrotechnical characteristics of steel is not an accidental one. Previously only 40-45% of steel batches were rated, on the basis of tests, as high grade steel E 330; with vacuum treatment of metal in the ladle the percentage increased to 90%, reaching 96 - 97% in some months (October-November, 1956).

Recently a still more effective method of metal treatment was tried out : the evacuation during transfer of metal from one ladle to another, the stream of metal passing through the rarified space. Such a method should ensure a higher degree of degasification and contribute to the production of high quality steel. Over 15,000 tons of various grade steel was treated by the method of transfer under vacuum. The testing of metal from the first experimental batches by the method of stepped turning revealed that the amount of steps containing a large number of cracks constituted 3.5% for steel treated under vacuum in the ladle, and 2% for the steel treated by the method of transfer under vacuum, while for the unevacuated steel it constituted 6.9%.

Oxygen is widely utilized in our Works in electric steelmaking. The use of oxygen in the process of charge melting reduces the time of melting by about 15 - 20 minutes and correspondingly increases the operating efficiency of the furnace, lowers the electric power consumption and assists in the decarbonization of metal during the oxidizing period of the heat.

Considerable difficulties were experienced in the introduction of oxygen into metal by means of iron tubes. It was not always possible to obtain these tubes (of relatively small diameter, 19 - 25 mm) in the necessary quantity and of the grade required.

A water cooled tuyere (Fig. 1) for the injection of oxygen into liquid metal was successfully developed and adopted in the electric furnaces at the end of 1956. The tuyere, fixed above the roof of the furnace, passes through an opening in the roof and in its working position is about 150 - 200 mm above the slag level. The movement and control of the tuyere are carried out by an operator from a panel near the furnace. The adoption of the tuyere sharply reduced the consumption of the scarce iron tubings, improved the working conditions of the operators and completely eliminated the time losses which previously were necessary for the replacement of burnt tubes by new ones. With careful operation the life of water-cooled tuyeres is 40 - 60 heats.

The increase in the number of steel grades manufactured with application of oxygen and the extension of this method to batches obtained by remelting alloy wastes, raised the metal output considerably and reduced the consumption of ferroalloys and the cost of steel (see table).

On the application of oxygen the economic indices of electric furnace operation improved, the reason being an increased utilization of alloy wastes in the charge and a sharp reduction in the use of expensive soft iron.

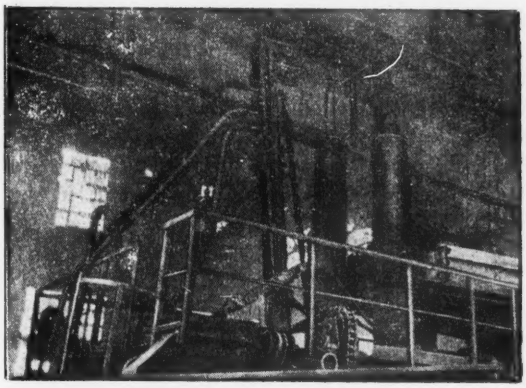


Fig. 1. Equipment of water cooled tuyere at the top of the furnace, for oxygen delivery.

Until recent times it was maintained that oxygen should not be used for blowing-through of the metal containing tungsten and vanadium, as both these elements burn out strongly during the oxidation process. However, tests showed that as far as tungsten is concerned this assumption is incorrect. Of course, the intense heating of the bath on oxygen blowing does not favor the course of the tungsten oxidation reaction, which takes place with heat evolution. Extensive practical evidence shows that the application of oxygen somewhat lowers the tungsten loss in burning. The vanadium loss in burning increases markedly on oxygen application, especially if there is a high vanadium content in the charge. Therefore, when the charge contains vanadium, oxygen as a process intensifier should be used only to a limited extent.

Some difficulties may be encountered in the process of phosphorus removal during the operation with oxygen because a successful dephosphorization requires lowering of temperature while oxygen strongly increases the bath temperature. Two methods can be recommended for a possible complete removal of phosphorus. In order to obtain a very low phosphorus content (about 0.005% or less). oxidation of the metal to 0.10% of carbon should be made with iron ore, and the oxidation to a lower carbon content (e.g., in making transformer steel – to 0.02% C) should be carried out with oxygen. Special attention should be given to maintaining basic lime slags and to their continuous renewal so as to prevent a back transfer of phosphorus from slag to metal at the end of the oxidation period when the bath is very hot.

In ordinary steelmaking such a high degree of dephosphorization is not required; hence there is no need to complicate the oxidation period. In that case the second method may be applied: to maintain an adequate basicity of the slag during the process and at the end of the melting period. On using 2.5 – 3.0% of lime and applying oxygen (about 0.10 – 0.15% C burns out under such conditions) it is possible to obtain 0.015 – 0.025% P, whereas the phosphorus content usually is 0.05 – 0.07%.

The application of oxygen in the process of steelmaking by the method of remelting alloy waste and a partial oxidation of the bath makes possible the prevention of chromium oxidation. Therefore, on oxidation of the bath with oxygen (instead of ore) the amount of chromium oxides in the bath is reduced. The partial oxidation of the bath with gaseous oxygen, in heats treated by the method of alloy waste remelting, makes it possible to use ordinary carbon-containing scrap instead of soft iron in the charge for the heats. The cost of steelmaking is thus considerably lowered.

The modernization and the enlargement of the electric furnaces carried out during 1955 and 1956 was of great significance for the increase of electrosteel output; the 10-ton capacity furnace was completely redesigned: charging boxes were replaced with bucket charging and the weight of charge was increased.

Simultaneously, with the rebuilding of furnaces, steps were taken to eliminate bottle-necks in the adjoining sections of steelmaking plants.

The modernization of furnaces made possible an increase in electrosteel output of tens of thousands of tons annually.

The use of chrome iron ore for fettling the furnaces producing stainless steel increases the life of furnace linings considerably, reduces the time loss on stoppages for fettling and markedly lowers the consumption of magnesite powder. The fettling of furnaces with a mixture of 35 – 40% chrome iron ore and 65 – 60% magnesite powder gave satisfactory results. Such a mixture sinters quickly and adheres well.

Electric Furnace Operation With and Without Oxygen

Item	12KhN3A – 20KhN3A		12Kh2N4A – 20Kh2N4A	
	without oxygen	with oxy- oxygen	without oxygen	with oxy- gen
Useful output, %	85.8	90.5	86.6	87.1
Consumption, kg/ ton:				
ferrochromium	9.3	5.0	20.5	14.0
nickel	22.1	13.9	24.0	19.0

The change from ingot forging to ingot rolling had a considerable economic effect. Previously, some high-alloy steels (Kh23N18, Kh10S2M, Kh9S2, Kh25T and others) were cast into small ingots and forged under hammer into billets which were subsequently rolled into sections. The operating cost constitutes 70 rubles per ton of product in the rolling plant and over 200 rubles per ton of product in the forging plant. The casting of small ingots for forging costs more than the casting of larger ingots for rolling. The replacement of forging by rolling results in a substantial saving and shortens the metal working cycle.

Central Avenue in the Works.

A considerable improvement in the operating efficiency was obtained as a result of raising the ingot weight from 2080 to 2850 kg. An extensive preliminary study of the 2080 kg ingot was carried out, including analysis of the results of tests on macrostructure, mechanical properties and other characteristics of a great number of various grade steel batches. The feasibility of large cross-section ingot rolling was tested in the rolling plant. In particular, the power requirement of the roughing mill gave rise to some apprehension. Works innovators came to the rescue and proposed a new system of current feed for mill motors. The adoption of this system allowed a considerable increase in the load on the roughing mill motor.

The electric furnace stoppages, caused by the delay in the assembly of molds for casting, decreased markedly owing to the increase of ingot weight; the throughput capacity of the soaking pits in the rolling plant rose substantially, as the ingot weight increased by 37% while the time of heating increased, on the average, only by 13 – 15%. Moreover, the operating efficiency of the roughing mill increased on rolling larger ingots, owing

to a relative reduction in the actual rolling time. The increase in the actual rolling time, because of the greater number of passes for producing billets of the same section from 2850 kg ingots (instead of 2080 kg), was relatively smaller than the increase in weight.

Until recently, high-speed steel was cast only in small ingots of 300 kg. On forging large billets from such ingots the degree of carbide nonuniformity was hardly lowered because of the limited amount of forging. Hence the weight of the initial ingot had to be increased to allow for a greater amount of forging. The change to casting of high-speed steel into 500 kg and even 700 – 1000 kg ingots (the latter are still in the experimental stage) resulted in a substantial improvement of metal microstructure with respect to the carbide nonuniformity. At the same time, the work in the casting bay of the steelmaking plant is facilitated because of the smaller number of molds which have to be assembled for each heat.

Extensive work was carried out regarding the mechanization of labor-consuming processes in all the main plants of the Works.

The charging of slag-forming materials into the electric furnaces during the steelmaking process was mechanized (Fig. 2). The personnel of the Works, having seen a machine invented by Plyuiko on the ferroalloy works tried to adopt it for charging lime and other materials. After extensive alterations it was found possible to use this machine on the electric furnaces of our Works also. The slag-forming materials are now charged by the machine alone during the steelmaking process, thus facilitating the task of steel workers, especially at large furnaces.

The adoption of by-pass equipment on the small section mill of the plant became possible only after making the roller housing (Fig. 3) (according to the innovation proposed by a team of our inventors led by comrade Chukanov) which can be mounted on the mill in place of ordinary channelled guides. Rolling with roller guides is carried out easily and reliably, whereas with the old channelled guides this operation was rather difficult. It would not be possible to operate the by-pass equipment efficiently on a mill with old channelled guides.

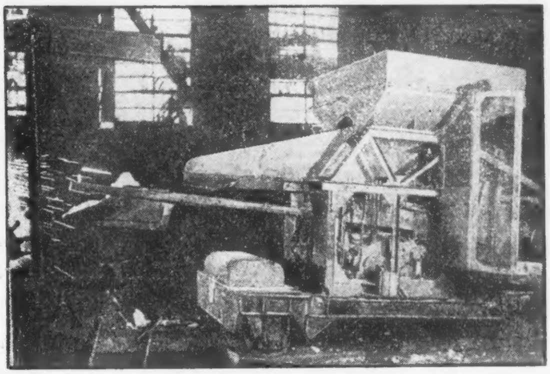


Fig. 2. Machine for charging slag-forming materials into the electric furnace.

Many units in the rolling plant were modernized: a manipulator for billet tilting was installed on the lifting tables of mill 325; the rolling field on mill 550 was extended, thus allowing an increase in the weight of billets and resulting in an increased operating efficiency of the mill; the welding-on of rolls with hard alloys was introduced on mill 825 and 550, resulting in improvement in the quality of the product, reduction in mill stoppages for roll changing and doubling the life of rolls; manipulators were installed at all roughing hammers, thus facilitating the work of forging operators and increasing the operating efficiency. Ground-level removing

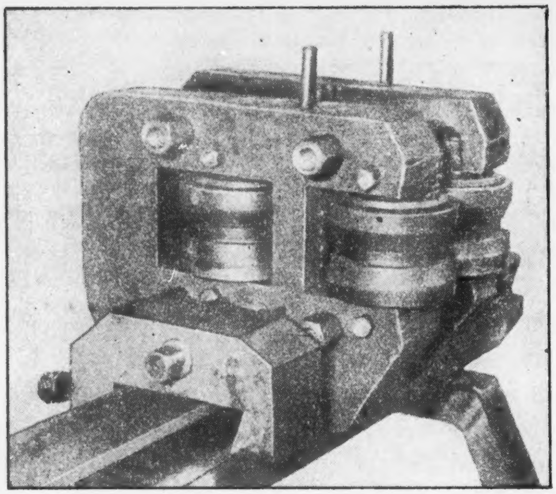


Fig. 3. Roller housing in the small section mill.

machines are at present being constructed and tested with a view to further mechanization of forging plant operations.

By improving existing equipment, adopting new techniques and advanced technological processes, the personnel of the Works achieves better results in their work.

PRODUCTION OF BALL BEARING STEEL IN LARGE ELECTRIC FURNACES

V.M. Sevastyanov

In electric melting shop No. 3 at the Dneprospetsstal plant, ball bearing steel is produced in 40-ton electric rurnaces. The furnaces are equipped with magnesite-chrome roofs (300 mm brick), the walls are lined with rammed blocks (50% magnesite and 50% dolomite powder with the addition of 7 to 10% of coal tar pitch).

The steel is produced on a fresh charge with full oxidation and by the remelting method (ShKh15SG steel is produced only on a fresh charge with a boil).

Oxygen is added during melt-down and oxidation. After the oxidizing slag has been pulled and a new slag has been built up from lime and fluorspar uniformly over the entire surface of the bath, the carbide mixture is added.

The metal is deoxidized with coke for forty minutes when a slag sample is taken which must contain not less than 2% CaC_2, not more than 0.6% FeO and not less than 55% CaO.

After the metal and slag samples have been taken, ferrochromium is added to the bath and the carbidic slag is transformed to a weakly carbidic slag. The slag is then deoxidized with a mixture of fine ground 75% ferrosilicon, lime and spar. The mixture is added to the furnace in small portions (4 to 5 times) every eight to ten minutes.

The shop receives low grade scrap containing 0.06 to 0.085% sulfur. The rate of sulfur removal is not great and in large furnaces it is slower than in small ones due to the lesser specific area of the bath and the inferior mixing of the metal. Maximum desulfurization rate is usually during tapping because of the mixing of the metal with the basic (limey) well deoxidized slag.

The process of desulfurization at the end of refining is associated with substantial technological difficulties. Renewal of the slag, which could be effected after its preliminary deoxidation by ferrosilicon powder would prolong the period of refining and adversely affect metal quality.

Steelmakers try to obtain, at the end of refining, a minimum sulfur content accompanied by a highly basic, active, well oxidized slag. In this case, when the metal is tapped with the slag through a large hole, the sulfur content of the finished metal is markedly reduced as will be seen from the data in Table 1.

The calcium carbide content of the final slag must be constantly reduced and not allowed to exceed 0.75%. A carbide slag "adheres to" the metal and increases the amount of inclusions in the steel. As will be seen from the data in Table 1, the lower the calcium carbide content of the final slag, the less the non-metallic inclusions in the steel:

Calcium carbide content in final slag, %	0.30	0.31–0.50	0.51–0.75	over 0.75
Average characteristic value of oxides	2.19	2.36	2.37	2.65

TABLE 1

Relationship Between Sulfur Content of the Finished Steel and Sulfur Content Prior to Tapping

Sulfur content prior to tapping	Number of heats	Sulfur content in finished metal, %							
		< 0.010		0.011–0.012		0.013–0.014		>0.014	
		No. of heats	%	No. of heats	%	No. of heats	%	No. of heats	%
0.020–0.023	4	3	75	1	25	—	—	—	—
0.024–0.025	31	11	35.5	6	19.3	6	19.4	8	25.8
0.026–0.027	52	15	28.9	17	32.6	11	21.2	9	17.3
0.027	13	2	15.4	6	46.1	2	15.4	3	23.1

After the metal is held in the ingot molds for 1 hour 40 minutes, the hot tops are removed and the ingots are dispatched hot to the rolling mill. Ingots are rarely cooled in the molds.

The production of ball bearing steel in 40-ton furnaces is constantly increasing. Compared with 1952, it had increased 11.3 times in 1956 while, at the end of 1957, it had increased 13.6 times.

The quality of ball bearing steel is judged at the plant by the yield of good metal at first inspection. The higher the yield of good heats at first inspection, the better the quality. Below are comparative data on the quality of the metal produced in 40-ton and 20-furnaces, %.

	40-ton furnace	20-ton furnace
Yield of good metal after first inspection	71.0	74.2
repeated inspection	25.7	24.2
Of which:		
with the rejection of individual ingots	12.8	9.6
uphill or direct poured	12.9	14.6
without rejection		
Marked for repeated inspection because of:		
oxides	18.0	17.4
sulfides	4.6	4.82
globules	6.2	3.28
carbides	0.2	0.30

Thus, metal produced in 40-ton furnaces is more contaminated with globular or spheroidal inclusions which is evidently due to local overheating in the process of melting because of the impossibility of good mixing. The installation of electromagnetic stirring on such furnaces would make it possible to obtain metal of more uniform temperature, would speed up other processes and would greatly ease the labors of the steelmaker.

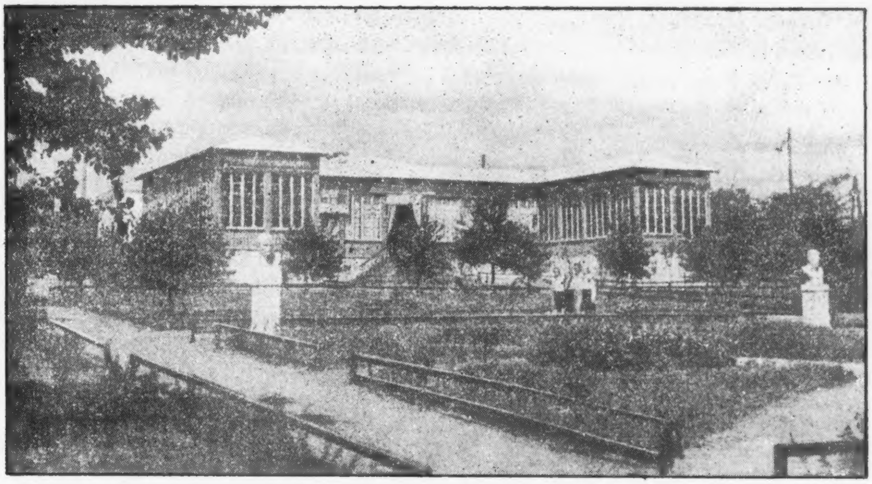
No substantial difference in the amounts of non-metallic inclusions in the metal, as between the 40- and 20-ton electric furnaces was observed in 1956. Average characteristic value for oxides in the metal was 2.28 for the 40-ton furnace and 2.25 for the 20-ton; average for sulfides was 2.07 for the 40-ton and 2.04 for the 20-ton furnace.

Table 2 shows the results of macrostructure examination of ball bearing steel in 1956, from which it will be seen that metal quality as regards macrostructure is about the same for each capacity of furnace.

TABLE 2

Macrostructural Examination of Ball Bearing Steel (Bar A) Produced in 20-Ton and 40-Ton Electric Furnaces

Furnace capacity, tons	Number of heats inspected	Characteristic value for central porosity								Characteristic value for central porosity					
		0.5–1.0		1.5		2.0				0–1		1.5		2.0	
		No. of heats	%	No. of heats	%	No. of heats	%	No. of heats	%	No. of heats	%	No. of heats	%	No. of heats	%
40	2386	2242	94.0	70	2.9	16	0.6	58	2.4	2329	97.6	50	2.1	7	0.3
20	1157	1064	92.0	33	2.9	7	0.6	53	4.5	1136	98.2	17	1.5	4	0.3



Pioneer camp "Dneprospetsstal."

PRODUCTION OF TRANSFORMER STEEL

V.A. Lakhno

Vladimir Alekseevich Lakhno, production inventor. In 1956 his brigade fulfilled their plan by 105%, producing 444 tons of steel above plan; during 5 months of 1957, they produced 258 tons of metal above their norm.

Our shop in the Dneprospetsstal plant began to produce transformer steel in 1955. According to the specification, the carbon content of this steel must not exceed 0.05% and the sulfur content, 0.008%. The production of this new class of steel proved to be very difficult. We were often outside the specification. A heat in the 20-ton furnace took up to ten hours. Furnace life did not exceed thirty heats. The hearth and banks often collapsed and we had to change over to the production of other grades of steel in order to strengthen the lining. The ingots of many heats exhibited coarsening of the structure after pouring.

It was essential to improve the technology of casting this steel in order to eliminate all these defects. At first, the amount of ferrosilicon powder added for the slag was cut from 300 to 150 kg; the addition of silicocalcium and aluminum powder was reduced and the consumption of lime was increased. These measures, to some extent, reduced tap-to-tap time.

Shortly after the first vacuum treatment trials, the specified requirements for the finished steel became more severe: new upper limits of carbon (0.02%) and sulfur (0.005%) contents were established. With the object of desulfurizing the metal at tapping, they began to add a mixture of choice lime and 60 kg soda to the ladle.

To improve desulfurization during the boil, metal temperature was raised and the addition of lime was increased. With this type of boil, about 0.015% of the sulfur was removed and the refining period began with a sulfur content of up to 0.020% though, in such cases, the furnace was operating under difficult conditions – the banks frequently collapsed and the walls were undermined. Fettling after tapping took more than one hour. Lining life of the furnace walls was reduced. As the metal was somewhat hotter than before, there was an increased tendency towards rising ingots.

By improving our technique, we lowered the sulfur content of the metal before the addition of lump ferrosilicon from 0.012 to 0.010%. The carbon content was reduced to 0.02% by blowing the bath with oxygen and this level of carbon was maintained throughout the refining period; sulfur was removed during the boil and refining down to 0.010%. To attain additional desulfurization, the metal was tapped with the slag and a mixture of lime, spar and soda was added to the ladle. With this technique, sulfur content was not more than 0.005%. Furnace life, however, remained at the low level of not more than thirty heats, after which it was necessary to take the furnace off for cold repairs.

In 1956, a vacuum chamber was assembled and put into operation which enabled us to run the heat hotter and the gases with which the metal was saturated could be removed in the vacuum chamber in ten to twelve minutes; rising ingots disappeared.

We have now established the following techniques for producing transformer steel:

1. Fettling and Charging. After tapping a heat, the furnace is tilted towards the working platform, the hearth and banks are carefully cleaned of all remaining metal and slag and are fettled with a thin layer of magnesite with sand and the furnace is replaced to normal position. Then, after having raised the electrodes, the worn patches are fettled, the electrodes are lowered to heat up these newly burned-in patches and the front columns are fettled with the spoon. In this state, the furnace is left for thirty minutes so as to harden up the fettled places. Then one charging box full of lime is charged onto the hearth and, if necessary, crushed electrode in amounts calculated to produce a melt-down carbon of up to 0.40%. The furnace is then switched on and the charging materials are added.

2. Melt-Down is carried out at maximum voltage. At the end of melt-down, small portions of ore, spar and lime are added to froth the slag. About 200 kg of ore are added in all.

3. Boil. The first sample is taken when a small amount of ore makes the bath begin to boil and the metal is well heated. The first slag is pulled in its entirety and a new, highly fluid slag is built up. Metal temperature is then measured and the ore additions are begun. As a rule, ore is added in three portions: the first – 60 shovelfulls, the second – 40 shovelfulls and the third – up to 30 shovelfulls. If, in the first sample taken at melt-down, the carbon content was about 0.40%, then, in the second, it would be about 0.25% and, in the third – 0.15%. After the last thirty shovelfulls of ore have been added to the furnace, the carbon content is lowered to 0.10%

During the ore boil, the slag foams well, the bath boils with small bubbles and the slag flows, of its own accord, over the sill. During the entire period of the boil, two men add lime. Such an ore boil makes it possible to remove more than 0.010% sulfur and to oxidize almost completely such elements as chromium, manganese and phosphorus. If the state of the charge leads us to expect a high carbon content at melt-down, oxygen is used to cut up the charge. There are cases where, for some reason, the carbon content at melt-down is high – up to 0.8 to 1.0%. In such cases, the metal is lanced with oxygen at the beginning of the boil and the ore boil begins at a carbon content of about 0.40%. It is observed that, the higher the carbon content of the steel, the more difficult it is to oxidize out the other elements.

When the carbon content of the bath has, with the aid of the ore, reached 0.10 to 0.15%, oxygen lancing of the bath begins. This process, as a rule, is carried out with the furnace switched off and at normal metal temperature. During oxygen lancing, samples for carbon, manganese and sulfur are taken every seven to ten minutes. When the carbon content of the metal has reached 0.02% and manganese and chromium have been completely oxidized, the entire slag is pulled.

During this period, strict attention is paid to metal temperature.

4. Refining. After the slag has been pulled, 130 kg of lump silico-calcium for partial deoxidation of the metal and 500 kg of a mixture of fluorspar with choice lime are added to the surface of the metal. After the slag mixture has fused, a metal sample is taken for carbon and sulfur analysis, the current is reduced and the slag is deoxidized with mixtures of lime, ground silico-calcium, ferrosilicon and aluminum powder. Rather more of the first mixture is added than of the last ones. After each portion of mixture has been added, there is a wait of up to ten minutes, the slag is well mixed and a sample is taken for sulfur. The slag sample, as a rule, begins to crumble after the addition of the first mixture. Metal temperature gradually drops.

If the process of deoxidation is correctly carried out, the sulfur content is gradually diminished. When a sulfur content of 0.010% is reached, the slag is thinned and lump ferrosilicon is added. After holding for fifteen minutes, during which time metal and slag are carefully mixed, tapping is commenced. Metal and slag are tapped together in a steady stream. Tapping temperature must not exceed 1580° C as measured with the immersion pyrometer.

All materials added to the furnace during the production of transformer steel are carefully roasted to avoid saturating the metal with hydrogen.

The metal is treated under vacuum in the ladle, being decanted from ladle to ladle. This operation usually lasts 8 to 12 minutes. The ladle full of metal is then teemed.

This technique enabled us to produce steel of the specified composition and to reduce the amount of scrap made.

ORGANIZATION OF WORK IN THE ELECTRIC FURNACE SECTION

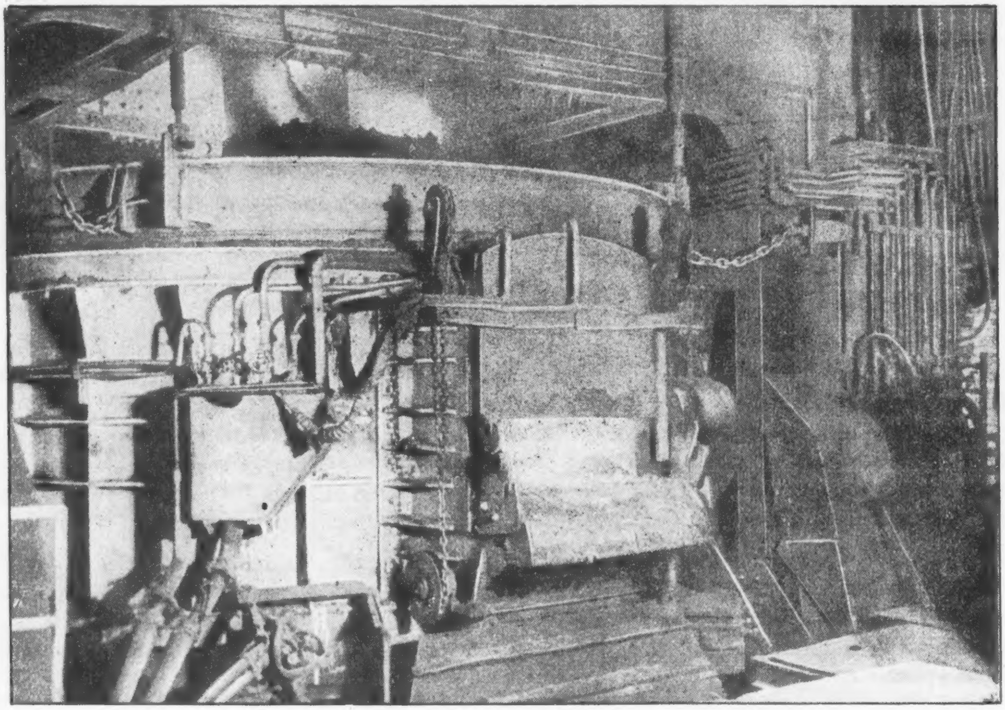
B. V. Barvinsky,
Smelting Foreman

The section under my supervision consists of three 20-ton electric arc furnaces. The furnace shells are of 4500 mm diameter and the electrodes 400 mm diameter. The furnaces are provided with transformers of 8000 kva capacity.

Hydraulic drives are provided for lifting the roof, removing the bath and tilting the furnace. The control of all the furnace mechanisms is effected from the control panel.

The furnaces are operated at a slight overloading, the output being 25–26 tons of metal in form of ingots for one heat.

The charge is delivered to the furnace from above by means of a bucket with opening chain sectors. The bath is rolled out from underneath the roof for filling.



20-Ton electric furnace.

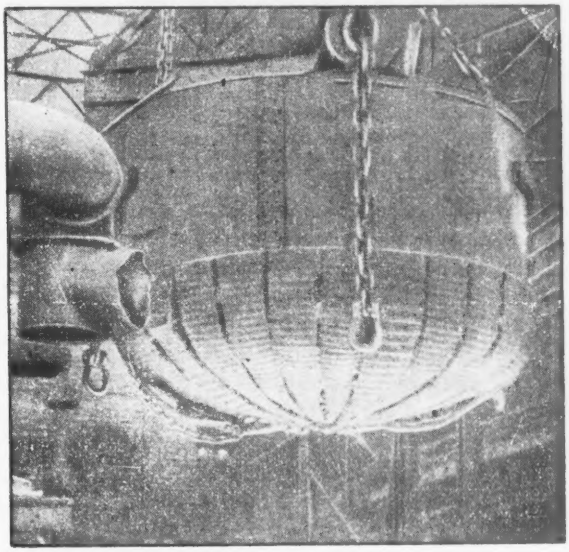
The time for the various operations on the furnaces is approximately as follows: preparing (fettling) 15–25 minutes, depending on the condition of the lining; charging 5–7 minutes; melting 2–2.5 hours; oxidation period approximately one hour; and refining – finishing of the heat – about two hours. For fettling the hearth and banks a pneumatic fettling machine is used, so that this operation is done quickly and easily. For the

intensification of melting, "undercutting" (melting from underneath) of the charge with oxygen is applied.

Various steel grades are produced in the electric furnace: ball bearing, alloy-structural, stainless and cracking (petroleum) steel. As far as possible the production of steel of a given grade is carried out on one and the same furnace. For instance, in furnace No. 1 mainly ball bearing steel is made. This is necessitated by the requirement of highly purified metal, free from nonmetallic inclusions. A high-quality steel can be attained only on an absolutely sound and non-softened furnace bottom and it is impossible to ensure these conditions with alternating production of high-carbon and low-carbon steel. The experience of the Works has shown that making steel of a given grade in one furnace is conducive to the development of skill among the furnace operator teams and leads to an improvement in metal quality.

Each furnace is operated by a team consisting of a senior steel worker, three assistants and one woman panel operator. The duties are allotted to each member of the team thus: the first assistant prepares ferroalloys and electrodes, and makes ready the outlet spout; the second prepares slag mixtures and fettling material and tilts slag pots; the third takes care of the tools and keeps the place tidy. Heavy and labor-consuming operations on fettling the furnace, during the oxidation period, on slag removal, and during finishing of the heat are carried out by all members of the team. The senior steel worker directs all the operations at the furnace, takes care that the right procedure and conditions are maintained and operates mechanical units.

Mutual assistance is widely practiced in the section. Very frequently the unoccupied steel workers assist the team of the furnace where a labor-consuming operation is in progress at that particular time: cleaning and fettling of the furnace, slag removal, and so on. Friendly co-operation among all the personnel of the section ensured a successful fulfilment of the 1956 plan and of the first half-yearly plan of the current year.



Charging of the furnace with the bucket.

Senior steel workers systematically instruct all team members, thus increasing their skill and qualifications. This policy makes it possible to interchange duties, or to replace any member of the team when necessary.

The foreman supervises all the work in the section. At the beginning of the shift he makes sure that all the furnaces are provided with the required materials. Depending on the grade of steel being made and on the competence of the particular steel workers, he turns his main attention to the part of the section where the most difficult operation is carried out.

The foreman entrusts the performance of some steelmaking operations to the senior steel workers. He is thus relieved from excessive duties and can more thoroughly supervise the most important work.

Nikolai Stepanovich Buinyi is a steel worker in the third steel-making plant. His team produced 1276 tons of steel over and above the plan in 1956, and in six months of 1957 processed 778 tons of metal over and above the planned production. His name has been inscribed in the Works Book of Honor.

Courses for improving the qualifications of the personnel are organized at the Works and are supervised by the foreman.

MODERNIZATION OF SECTION MILLS

B. M. Sergeev

Deputy Head of the Technical Department

The modernization of two section mills, 550 and 325, with a view to increasing their operating efficiency, was carried out in our Works in 1956 at a relatively small cost for materials and other requisites.

The rolling plant is the largest in our Works; it contains four section mills. Ingots of 2.08 – 2.85 tons are rolled on roughing reversible mill 825 into billets and large sections (circular section 120 to 180 mm and square 100 to 180 mm). The mill is fully mechanized. The finishing plant arranged in three bays, is located next to mill 825, followed by three section mills, 550, 325 and 280, placed parallel to each other. The most mechanized mill of these is light-section mill 280, which has a high operating efficiency.

Steel sections (circular section 45 to 120 mm and square 45 to 100 mm), mainly of alloy steel, are rolled on mill 550. The mill has four three-roll stands in tandem arrangement with one common motor. Before rolling, the billets are heated in two holding furnaces fired from below. Coke–blast furnace gas of 1300 cal/m^3 calorific value is used as fuel.

Lifting tables and roll tables are on the back of each stand of the mill; manipulators are at the front. In front of each stand there are roll tables with pull-over transfer, and behind the stands there are two saws, a cooler and a pull-off transfer.

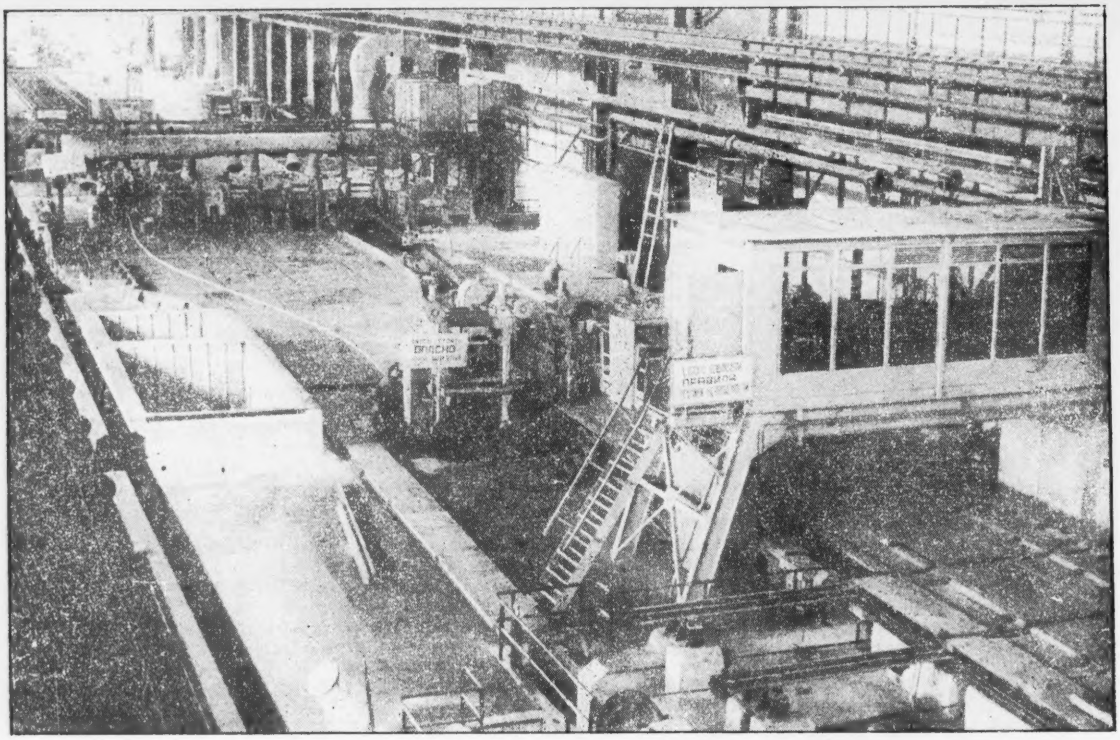
There were the following bottle-necks prior to the modernization. a) The roll-out field in front of the mill. On rolling 45 to 60 mm diameter sections the material could not be passed quickly from one stand to another. In order to facilitate the work of operators it was necessary to take billets of various sizes (125, 150 and 180 mm square) for different sections. b) Heating of billets before rolling. With the existing heating methods an intensive, speeded-up heating of alloy steel could not be attained. Moreover, because of a prolonged residence of the metal in the furnace the decarbonization of billets was rather high. c) Idling of the mill because of roll changing. d) Stoppages in cutting; the saw operators had to make great efforts in cutting high-quality metal and transferring it to the finishing plant.

Modernization of the existing equipment and modifications in the method of rolling were carried out in 1956 in order to eliminate all these bottle-necks and to increase the operating efficiency of the mill.

The roll-out field in front of the mill was extended and one additional pull-over transfer was constructed. Consequently, it was possible to change the cross section and increase the weight of billets for rolling light sections. While previously the 45 to 60 mm diameter bars were rolled from 125 mm square billets, they are now rolled from 140 mm square billets, the number of billet sections being reduced to two (instead of three) 140 and 180 mm squares.

Roller boxes were made and adopted for the rolling of circular sections. The modernized lines, with the shaft, were firmly mounted on a block. The adoption of roller boxes and the modernization of housings resulted in an improved quality of rolling. The bottle-neck at the saws was successfully eliminated: a removable brace and driving roller tables were installed, thus speeding up the cutting and improving the quality of the cut. The metal now is not cooled on the roller tables at the saws.

The adoption of the welding of hard alloys onto rolls increased the life of rolls nearly two-fold. Thus, while the untreated rolls last for six runs, or for 42 24-hour days (924 hot hours), the welded-on rolls work for eleven runs, or 77 24-hour days (1694 hot hours).



Light section mill 325.

By taking these measures we achieved a consistently more efficient operation of the mill; however, to ensure a high output, the problem of an intensified heating of billets had to be solved. The uninterrupted mill operation allowed an increase in the temperature of the metal heating to 1280 degrees C, and the reduced residence time of billets in the furnace resulted in a considerable decrease in the decarbonization of metal.

The mill operation improved: hourly output increased by 9%, idle periods decreased by 15%, metal waste due to faulty production fell by 22.5%. The work of operators was considerably eased.

The personnel of mill 550 succeeded in fulfilling the 1956 production plan ahead of time, and rolled more than 6,000 tons of metal over and above the planned output.

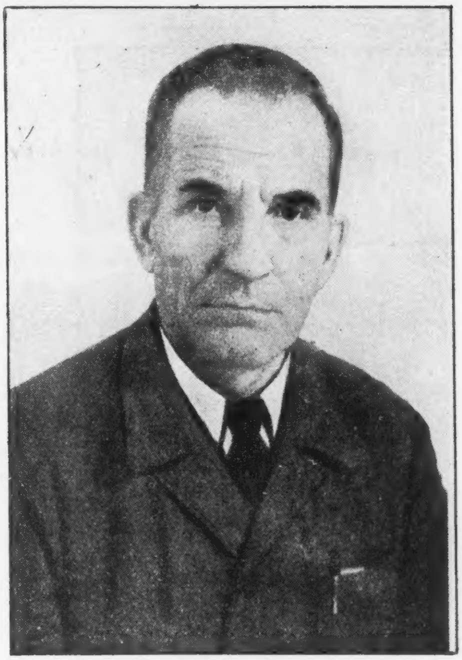
Mill 325 has two stands (one operating, the other in reserve) in the roughing train, and five three-high stands in tandem arrangement and driven by one motor in the finishing train. All stands of the finishing train are provided with ball bearings. The reducing stand of the roughing train has lifting tables with driving roller tables. Prior to the modernization, the rolled bars were fed to the stands by hand. The mill is equipped with flying shears and a movable cooler. Billets are heated in two holding furnaces fired from below, a mixture of coke oven and blast furnace gases being employed as fuel.

Alloy and high-alloy steels are rolled in the mill: rounds 20 to 40 mm diameter, squares 19 to 35 mm and strips 6 to 25 mm thick and 25 to 55 mm wide.

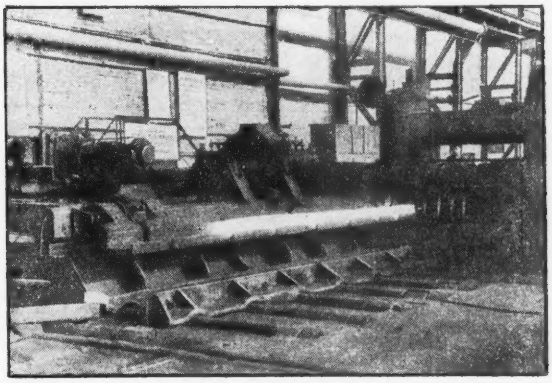
A great deal has been accomplished at this mill in the modernization of existing equipment and improvement of the technological process.

Setting up the manipulator line on the roughing stand made it possible to revise the design of rollers to make greater reductions, to dispense with one operator in each shift, and to ease the task of the workers considerably. The delivery roller tables from the furnace to the stand are automated.

One of the heating furnaces was somewhat modified. The front discharge of billets was replaced by side discharge, thus improving the heating conditions and preventing air from being drawn into the furnace.



Iosif Pavlovich Elizarov worked here from the day the Works first operated. As a senior foreman of the rolling plant he trained many a youth until his retirement. His two sons - Grigory and Ivan Elizarov - trained by him, are now foremen on mill 280, and they have been commended for their work on several occasions.



Manipulator line in front of the first stand of mill 550.

The modifications carried out in the first stand of the mill and in the heating furnace made possible an increase of 20 kg in billet weight, which also led to an improvement in the operating efficiency of the unit.

The rolling spaces on the finishing stand were extended, feed roller tables were installed and transfers were set up. In addition to the transfer equipment at the back of the mill, a transfer arrangement was set up in front of the mill for the transfer of material from the second to the third stand; a photoelectric pyrometer for measuring the temperature in the course of rolling was introduced.

Owing to the elimination of mill bottle-necks, the mill output increased by 4%, idle periods were reduced by 9.5% and faulty production was reduced by 16.5%

The mill operators produced 1620 tons of high-grade metal over and above the plan in 1956, at the same time achieving substantial savings in metal and other materials.

The changes carried out at our Works showed that the modernization of rolling mills is within the power of every works and plant (from the point of view of design as well as manufacture and erection of equipment).

Nikolai Stepanovich Zalutin, steelmaking operator of steelmaking plant No. 3, exceeded the state plan of 1956 by 1.7%, carrying out 131 speeded-up heats and saving 350,000 kw-hrs of electricity. This old worker has now retired. His name has been inscribed in the Works Book of Honor.

The modification of existing units and the setting up of new ones do not require large capital expense and can be carried out from local resources; the cost is quickly recovered owing to the increased output of the mill.

PROPERLY HEATED INGOT — GUARANTEE OF SUCCESSFUL MILL OPERATION

I. D. Vereshchak
Senior Operator of the Soaking Pits of Mill 825

The large-section mill 825 of our plant rolls mainly billets from alloy and high-alloy steel ingots of 2 - 3 tons for section mills. In addition, large sections — rounds of 130 - 180 mm diameter and squares of 105 - 200 mm — are rolled here.

The mill consists of two reversible two-high stands, both stands driven by one motor. The rolling process is fully mechanized. There are 10 compartments (5 groups) of regenerative soaking pits heated from the center of the bottom for heating the ingots before rolling. The pits are fired with a mixture of coke oven and blast furnace gas of calorific value 1300 cal; their operation is automated. Ingots are placed along the walls of the compartments, preferably in one row, the hot top up. 18 to 24 ingots are charged into one compartment, depending on ingot weight.

When ingots are placed in a second adjoining row they have to be turned at the time of malleablizing; it ensures a more uniform heating of the adjoining ingots.

Most of the heating compartments operate at high temperatures as the ingots are charged while hot (750-850° C). One or two compartments are used for heating up; in these, cold ingots of alloy steel are heated to 800 - 900° C and are subsequently transferred to compartments at high temperature.

The heating up compartments are working under most difficult conditions as they have to be cooled regularly from 800 - 900° C to 300 - 350° C.

The time of heating depends on the steel grade and temperature of the ingot: for cold ingots, the total time of heating is 4 to 10 hrs; for hot ingots, it is 2 hrs 35 minutes to 4 hrs 15 minutes.

All steels (over 200 grades) which are rolled in the mill are divided into 10 groups and subgroups according to the heating regime. The first group includes carbon tool steel and high-carbon grades of structural steel. The method of heating these is as follows: hot ingots at a temperature not below 750° C are charged into the compartment, heated to 900 - 1000° C, and the cover is placed in position. For 15 minutes the ingots are kept in the compartment with the gas cut off. The ingots are then heated gradually for 1 hr 35 minutes to the required temperature (1260° C by the potentiometer reading), kept at that temperature for 1 hour and then transferred for rolling. The temperature of the metal in this group of steels should be within the limits of 1090 - 1130° C (by pyrometer reading), after the third pass in the mill.

The ingots of ball bearing steel (the fifth group) are heated differently: hot ingots (at 800 - 850° C) are charged into a compartment heated to 900 - 1000° C, are kept without gas firing for 15 minutes, are then heated at a uniform rate for two hours to the required temperature (1230° C), and kept at that temperature for 2 hours. The temperature of the metal after the third pass should not be below 1100 - 1140° C.

The most complex with regard to heating is group VI-b, which includes such grades as 18KhNVA, 40KhNMA, 30KhGSNA, Kh25T and others. When cold ingots are charged for heating the procedure is as follows: the cold ingots are charged into the compartment heated to 550°C and kept for one hour with gas cut off (in order to heat up the ingot to the temperature of the compartment); then the temperature is raised to 800°C for 4 hours. The ingots are kept at that temperature for an 1 hour, then transferred

to the heating compartment which should be at 900 - 1000° C, and a uniform heating of ingots to the required temperature (1270° C) is continued for 2 hours 30 minutes. When this temperature has been reached, the ingots are kept in the compartment for another 2 hours. The temperature of the metal at the commencement of rolling should be 1130 - 1180° C.

Hot ingots are heated in a similar manner to pre-warmed ingots, the only difference being that after the charging of hot ingots into the compartment they are kept for 15 minutes with gas cut off and the heating up to the required temperature is attained 30 minutes earlier.

The ingot-heating regimes described above are specified for heating 20 - 24 ingots in a compartment. On charging a smaller number of ingots into compartments the time of exposure of the ingots at the required temperature is reduced, and in the case of a larger number the time of exposure is increased due to the reduced rate of heating up to the required temperature.

When ingots of two different groups are charged into a compartment, the heating is carried out according to the regime for the group which has to be heated more slowly.

The automation of the soaking pits and the selector contact with the mill enable our team of furnace operators to provide the mill with a regular uninterrupted supply of heated ingots which, in turn, assists in the successful work of all the personnel on the shift. A strict observance of the heating regime of ingots contributes to a 50% cut in faulty products caused by heating defects (overheating, non-uniform heating etc.).

The personnel of our shift produced 7104 tons of rolled steel over and above the plan in 1956. There is no slackening in our work this year.

Senior welder Ivan Dmitrievich Vereshchak fulfilled the annual plan of 1956 as early as December 10th. The shift in which he worked produced an additional 7104 tons of rolled steel in the rest of the year. In six months of 1957 this team produced 2837 tons of metal over and above the plan.

Lenin Avenue — the main street of the town (on the left are the buildings of the "Dneprospetsstal").

Our team has contributed to this glorious jubilee - the twenty-fifth anniversary of the Works - by the production of hundreds of tons of metal over and above the planned targets.

IN THE FORGE PLANT

I. N. Blagoveshchensky

Senior Foreman in the Forge Plant

The forge plant was completely rebuilt and put into operation in 1950, its old character being retained: that of a forge shop of drop forging for the production of steel sections, round, square and rectangular sections of tool, stainless and other high-alloy steels.

Thirteen forging hammers — the weight of the dropping part from 1 to 5 tons — were installed in the plant. The hammer operation was not mechanized (Fig. 1)

In the course of 1950 - 1951 only low-alloy structural, ball bearing and carbon tool steels were forged in the plant. Thus the plant workers had the opportunity to master the process and to prepare for the forging of hard steels including high-speed steel.

From 1951 onward the assortment of steel subjected to forging was continually widened. While in 1951 and 1952 the hard grade steels forged in the plant constituted 1.4% and 6.1% of the total, respectively, in 1956 the output of these steels constituted 65%. Medium-hard metal forged in 1956 constituted 32%, and soft only 3%.

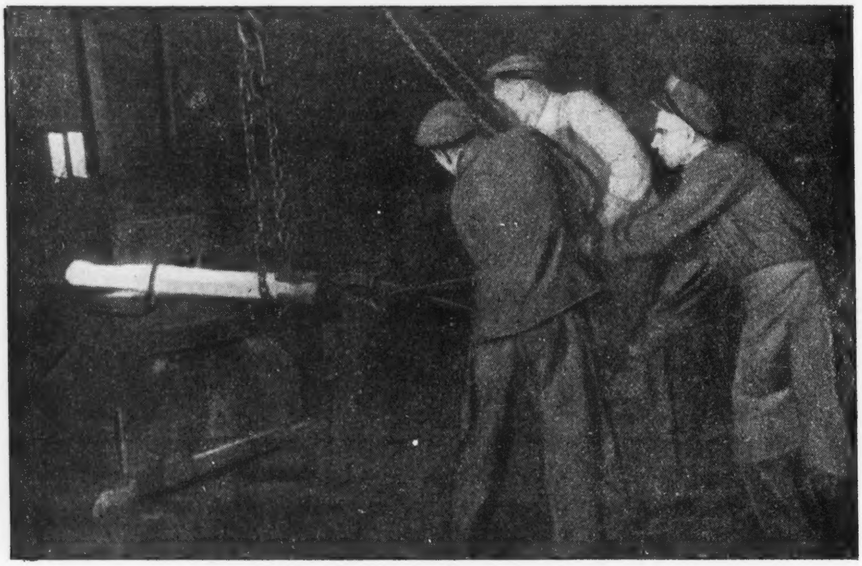


Fig. 1. Manually operated forging of metal.

From 1950 onward the personnel of the plant, in collaboration with the TsZL (Central Works Laboratory) workers, have done a great deal for the improvement of technology and mastering of new high-alloy steel forging.

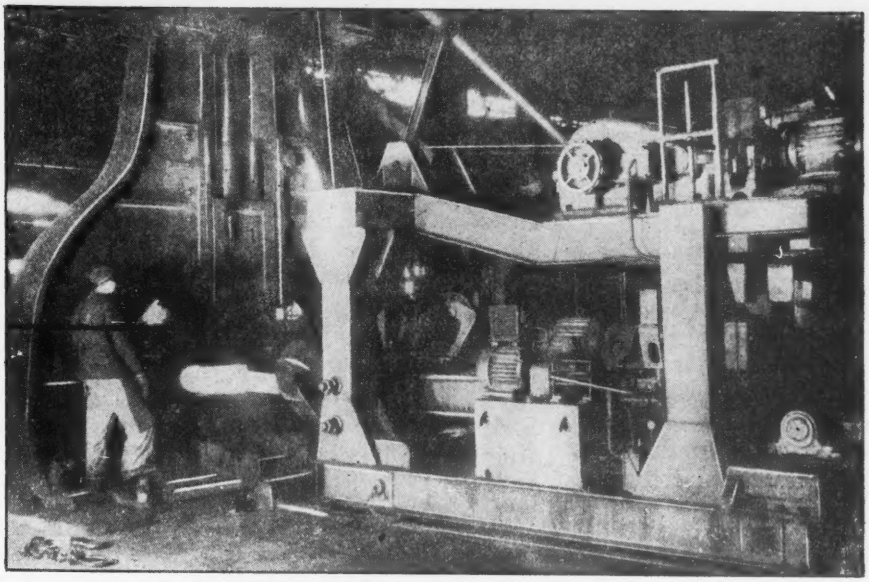


Fig. 2. Forging with manipulator.

At present in the forge plant there are well established methods of heating steels susceptible to carbide and cementite structure formation (KhVG, KhG, Kh, U10A, U12A), as well as steels susceptible to large grain formation (Kh25T).

In 1956, the operators mastered the forging of circular section 160 - 200 mm diameter directly from ingots, by means of shaped dies. Thus superfluous operations were eliminated.

The elimination of faulty products, due to decarbonization, was approached from two directions: the over-exposure of metal in holding furnaces was eliminated and a liquid glass protective lubrication of billets for sections of less than 50 mm diameter (or thickness) was introduced.

With a view to eliminating the decarbonization and naphthalene-like (flake) fracture, the high-speed steel began to be forged without the intermediate heating up (for medium sections of 80 - 100 mm diameter).

Simultaneously with the improvement of production technology, the main process began to be mechanized as from 1955. The 5-ton hammers were equipped with forging manipulators of 5 ton and 2 ton capacity (Fig. 2).

In May, 1956, a mechanization team was organized in the plant and it made, in collaboration with other plants of the Works, two forging manipulators for 5-ton hammers . Both manipulators are already in use and have proved to be well made and assembled.

After the adoption of manipulators, the hammer team was reduced from 10 to 6 men. As a result of the installation of four manipulators in the plant, 48 men were free to be employed on other jobs.

Two charging machines for charging ingots into the chamber furnaces and the removal of billets and metal scrap from the 5-ton hammers were set up in May, 1957. At the same time an improvement in the hot stamping of metal, with typesetting stamps directly on the hammer head, was carried out. For handling metal delivered to the slow-cooling pits, receivers were constructed into which metal was loaded by charging machines and then transferred by cranes to the slow-cooling pits. The introduction of charging machines and receivers almost entirely eliminated heavy labor in the transportation of metal by hand bogies.

Manipulators for metal forging under the 3-ton hammers will be made in 1957.

At the present time, the mechanization team is engaged in the modification of a small manipulator with a view to trying it in the operation of 3-ton hammers. The control of manipulators is concentrated on control panels placed near each hammer.

In the finishing section of the plant there are grinding machines with exhaust fans, gag press and saws.

The work carried out so far is only the beginning of the mechanization of labor-consuming processes and the improvement of heating and forging technology.

THE ROLLING MILL OPERATORS

G. M. Bannyi

Chairman of the Plant Committee of the Rolling Plant

The "Dneprospetsstal" produced the first batch of high-quality steel 25 years ago. In 1949 the construction of the rolling plant, destroyed during the war, was begun anew. A year later our country again obtained our high-quality Zaporozhe steel. In 1950, mill 825 was put into operation.

In the course of constructing and starting operations on the plant, the training of mill operators was not forgotten. Groups of workers went through theoretical and practical training at the "Electrostal", "Azovstal", "Zaporozhstal" works and other establishments. Great assistance was rendered by workers and foremen who returned after wartime evacuation: senior foreman Krylov, senior furnace operator (now foreman) Makeev, roll designer Sapronev, foreman Elizarov and engineer Vasilevich.

In 1953, the mill operators achieved a new success – the construction of the plant was completed and the last (fourth) mill 280 was put into operation. The Works began production of 8 to 180 mm sections.

The personnel of the "Dneprospetsstal" rolling plant was mastering the new equipment and increasing the operating efficiency day by day. In October –November, 1950, a record of rolling 60 - 70 2-ton ingots on mill 825 in one shift was achieved. These first records were made by senior operators Bondarenko and Fedchenko. In 1951 - 1952, to roll 134 - 170 ingots in a shift was considered a maximum, and in 1956 up to 260 ingots were rolled. Outstanding workers of our plant - senior operator Chernyak, senior furnace operator Vereshchak, senior cutter Udalov - fulfilled the 1956 annual plan by Dec. 10th. They produced 7104 tons of rolled material over and above the schedule. The foremost workers are not slackening the pace this year. In six months of 1957 they produced 2837 tons of rolled material above the schedule.

Senior operator Ryazantsev and senior rolling mill operator Shvets completed their annual production program by Dec. 16th 1956, and produced 5335 tons of rolled material in excess of the annual planned output. In 5 months of 1957 these workers produced 2081 tons of rolled material above the planned output.

Foreman Manusov, senior rolling mill operator Shalimov and many others do not lag behind.

On the results of production for the third quarter of 1953 the plant was given an honorary title of Outstanding Plant of the Soviet Union for the first time and received the Challenge Red Banner of the USSR Council of Ministers and of the VTsSPS.

Such success is due to the improvement of process technology, adoption of new methods, higher qualifications of workers and technical personnel. The organization of production in the plant is improved and the role of the foreman as the main organizer of production operations is enhanced.

A decisive part in the achievement of such good results was played by traditional competition between the rolling plants of the "Dneprospetsstal" and the "Electrostal" Works. On most occasions our plant was victorious in this competition.

The personnel seek further means of increasing the output of rolled material. We are working on the improvement of ingot heating conditions, increasing the durability of rollers, introducing mechanization and automation in individual sections of the plant. Thus, turning sleeves replacing drawing rollers were installed on mills 325 and 280; roller housings instead of channel passes were adopted on mills 550, 325 and 280; roller housings, in place of leading-out, work well on mill 280. There are many innovators and inventors in our plant: Ukholin, Magda, Zhekhovanov, Loktionov, Yatsenko, Guba and others.

By widening the extensive Socialist competition for the fulfilment of the historical resolutions of the 20th Congress of the KPSS (Communist Party of the Soviet Union) the personnel achieved new production successes: on the results of the All-Union Socialist competition the plant retains, for the fourth quarter in succession, the Challenge Red Banner of the USSR Council of Ministers and of the VTsSPS.

The personnel of the plant, while fervently approving the decisions of the December and February Sessions of the Central Committee of the KPSS perseveres in exploring all potentialities in order to achieve the annual target ahead of time and to mark the 40th anniversary of the great October Revolution.

The senior operator of mill 825, Nikolai Konstantinovich Chernyak is well known in the rolling plant of the Works. The team under his leadership achieved the 1956 target ahead of time and produced an additional 7104 tons of rolled metal. The target for this year has also been exceeded and the rolling mill operators gave the country 2837 tons of rolled material over and above the planned output. The name of N.K. Chernyak has been inscribed in the Works Book of Honor.

The personnel of the rolling plant undertook to produce 10,000 tons of high quality rolled material above the plan in 1957. In only five months, 6952 tons of rolled product has been produced already towards this target. We are confident that all the obligations undertaken will be successfully fulfilled.

MY WORK IN THE FINISHING PLANT

V. Ya. Marchenok

Grinder in the Thermal Plant

I came to "Dneprospetsstal" in 1952 and began my work as a grinder in the thermal plant. With me came my present friends Galina Sarabun and Lena Fateeva.

I was somewhat afraid in my first days at work: the noise of the machines and cranes and signals was frightening - after all, I was living in a village before I came to the Works.

I learned my trade from an experienced woman worker who devoted a great deal of time and attention to me. She acquainted me with steel grades and the behavior of different steels under treatment on the grinding machine, passing to me her many years experience.

Grinder Valentina Yakovlevna Marchenok, is one of the best woman workers of the thermal plant. She achieved 156.2% of the planned norm in 1956, and in the 5 months of 1957 — 165% of the norm.

Soon my friends and I mastered our work as grinders and grew to like it. We learned which abrasive disc is to be used for grinding this or that steel and began working on our own.

What is our work like? During the five minute instruction period the foreman tells us the task for the shift and on which steels we have to work. I prepare my working bench and tools according to the task: for hard steel grades I use soft discs, for soft grades - hard discs. A proper organization of work, a judicious selection of grinding discs and good mechanical condition of the machine greatly facilitate the work of a grinder and contribute to an increased operating efficiency.

The reduction of time losses on auxiliary operations and on preparatory and finishing work are also of importance.

Thirty minutes before the commencement of the shift I carefully inspect the machine, test whether it is in good working order and check the amount of steel which is on the bench and which will have to be ground at the beginning of the shift.

When grinding bars, I polish as the machine moves in one direction and inspect the bar and remove any defects on the reverse motion of the machine. Sometimes, for a better and quicker removal of defects, especially cracks, it is necessary to press the machine harder, setting it at an angle to the worked bar.

Bars of square section are worked better several at a time. Such a method reduces the time losses on auxiliary operations on each bar almost in direct proportion to the number

The team led by steel worker, Askhat Shagimardynovich Usmanov, produced 1139 tons of steel over and above the plan in 1956, and 333 tons of steel above the target in six months of 1957. The name of the steel worker A. Sh. Usmanov has been inscribed in the Works Book of Honor.

Honored Metallurgist, Mikhail Akimovich Boiko has been employed in the Works since its establishment. In spite of his right to retire, he does not leave the job and continues to work as a steel worker. In 1956 M.A. Boiko achieved 138.9% of planned production and in the six months of 1957 - 113.3% of planned production.

As in the finishing shop, metal of various hardnesses and with various type surface is dealt with, some women grinders endeavour to take only the more easily worked metal. This leads to misunderstandings and discordant work and consequently reduces the operating efficiency considerably. In isolated cases it results even in unjust remuneration, for each grinder is paid according to the material finished and handed in to the OTK (Department of Technical Control), and if the metal is better finished, the grinder can receive high pay for a rather small effort. Such was the organization of work in our section until 1956.

We suggested a new work system which assists the rise of operating efficiency, eliminates controversies and unites all women grinders into one friendly community. The work is now organized on a team principle; a team consists of 4 - 5 grinders and one cutter. The rate of payment is calculated on the basis of each ton of finished material handed in by the team. Now there is no convenient or inconvenient metal: all the worked metal belongs to the team and is distributed among the members of the team according to the working time of each worker.

With the new system, operating efficiency increased and faulty production decreased. In each team the advanced experience and practices of the best grinders are studied and adopted; new proposals are discussed in the trade group and the accepted ones are adopted in production operations.

A planned lay-out of the working bench, time saving on auxiliary, preparatory and finishing operations, the elimination of unproductive time losses and idle periods during a shift - all of this contributes to an increase in operating efficiency in the finishing plant.

THE ORGANIZATION OF WORK AND THE INCREASE OF THE PRODUCTIVITY OF LABOR

G. K. Smetanin

(Head of the Work Organization Section)

In the past year the workers and staff fulfilled with honor their Socialist pledge by producing thousands of tons of high-grade steel in excess of the production plan.

Although the target set by the State was considerably higher than the level of production actually achieved in the last year, the steelmakers promised to produce in 1957 10,000 tons more of high-grade steel than were scheduled and substantially to improve the quality of the metal. The steel rollers promised in their Socialist pledge to produce 10,000 tons of rolled sections in excess of the output plan, and also to reduce the cost of the steel they produced. The increase in the productivity of labor in 1957 will be 3% above the planned figure.

During the past five years the output per man invariably increased from year to year and was (1952 = 100%):

1953 .... 106.1

1954 .... 125.5

1955 .... 158.7

1956 .... 176.0

The rise is not only due to the increased volume of production, but also to a reduction in the number of workers; this was achieved by the better use of working hours. There were also changes in the planning of work, trades were combined and labor-consuming operations were mechanized. In 1954 the number of workers was reduced by 189, in 1955 by 451, and in 1956 by 363. This freed labor for the starting of many new projects.

At present, experiments are in progress in the pouring of alloy steel into mold under the protective atmosphere of a neutral gas (argon). This method will enable the ingots of stainless chromium-nickel steel to be machined to a depth of only 4-5 mm, whereas 20-25 mm per side must be removed from ingots poured in the ordinary manner. This will considerably improve the net output of metal from each heat.

The productivity of labor was also influenced by a change in the method of introducing oxygen into the bath. Previously, oxygen was supplied by means of lined pipes which had to be moved by hand. Now, special water-cooled ports have been developed and constructed which supply oxygen through the roof of the furnace. This has rendered the work of the operators easier.

In the rolling shop, flame cleaning of the rolling blanks has been introduced. The work was organized on the gang principle, which enabled over 40 operators engaged in chipping and grinding work to be released. In addition, the productivity of the finishing section was substantially increased.

A large reduction, (over 30%), of waste was obtained by the installation at the rolling mills of roller boxes and guides. The result was an increased rate of rolling and easier work for the operators.

Work on the automation of light-section mills is being continued.

In the forge the hammers were fitted with manipulators which again made the work of the operators much easier and enabled 33 operators to be transferred to other work. The re-arrangement of the working week enabled the number of grinding-wheel operators to be reduced by 34.

In the heat-treatment department, the adoption of up-to-date methods of cleaning metal and the organization of independent teams permitted the number of grinding-wheel operators and chippers to be reduced by 45.

The installation of a pipeline for the supply of oxygen resulted in the reduction of the number of benzene-oxygen cutters and their assistants by 11.

The mechanization of auxiliary tasks and the use of belt conveyors in loading and unloading operations rendered the work of loaders much less strenuous. To date their number has been reduced by 9.

The installation of automatic controls in transformer substations led to a cut in their personnel by 7 duty operators.

The adoption of new methods and of increased cutting rates in roughing operations and the general reduction in the amount of crane work and repairs enabled the number of workers to be reduced by 65 men in 1956.

Owing to these measures the general increase in the productivity of work scheduled for four months of 1957 was exceeded by 7.1%. The operators in melting and rolling shops head the list.

At the No. 1 melting shop, melter Loy's gang was awarded the title "Best Steel Melting Gang". It regularly exceeds the production plan (for four months of 1957 by 104.5%) with only 0.02% of waste. In the No. 3 melting shop, melter Buiny's gang completed the plan for the 1st quarter of 1957 ahead of schedule and exceeded it by 107.5%. Operators of the 825 mill (led by Comr. Ryantsev) fulfilled the output plan of the 1st quarter ahead of schedule and the operators of the 280 mill (foreman Manusov) also fulfilled the plan for 1956 and the 1st quarter of 1957 ahead of schedule. In the forge the gang led by Shishlov achieved an output of 129.7% in the 1st quarter.

There are many workers of this type at the plant. By applying the most up-to-date techniques and by the proper organization of work, they regularly increase the output of machines and furnaces and improve the quality of production.

65% of works employees and 70-75% of those working in the main production departments (melting and rolling shops) are young people. Our daily achievements are often due to the creative energy and fighting spirit of the young steel workers.

The fulfilment and over fulfilment of the output plan is to a considerable extent due to the direct participation of the workers, engineers, and the clerical staff in the life of the works, and the active control of its functions. At the productivity conferences which take place in each department and section many useful suggestions are made with regard to the improvement of work.

For example, in deciding the measures aimed at improved production in 1957, 47 meetings were held in the various departments; they yielded 296 suggestions, 149 of which were adopted at the interdepartmental conference.

Many valuable suggestions were adopted at works conferences on safety problems, held in May 1957.

In order to check the fulfilment of pledges made by departments and invividual gangs, the output figures are produced not monthly but weekly, each Saturday, and discussed at the joint meeting of the works committee and management. They take into account the work of departments, shifts, mills, and furnaces. In addition, the weekly report contains the results of competitions, with regard to the quality of work, between the heads of shifts, chief foremen, foremen, steel melters, pit workers and workers of other trades. The first places are awarded to those who produced least waste. The results are immediately made known to the personnel.

If a person or a group has retained the first place for a month, he is given a monetary reward. This system stimulates the improvement not only of the quantity but also the quality of work.

The implementation of the suggestions made at productivity conferences, aimed at the increase of output and the reduction of rejects, will enable an additional 10,000 tons of metal to be produced.

Our works were the initiators of the competition between the enterprises of the Zaporozh region to mark the 40th anniversary of the Great October. We accepted the challenge of the Dnepr Aluminim Works and, in turn, challenged the "Zaporozhstal" plant and increased the pledge.

Smith Dmitry Pavlovich Shishlov regularly exceeds the fixed output rates: he fulfilled the plan for 1956 to 125.8% and the plan for the first six months of the current year to 126.0%. Together with the names of other distinguished members of the plant his name is entered in the Works Book of Honor.

Honored Metal Worker Mikhail Semenovich Semikopenko, who initiated the movement of high-speed melting at the works, has begun his well-deserved retirement. When he worked at the plant he taught the high-speed melting technique to many young steel workers.

By expanding still further socialist competition and by the exchange of experience between the lead steel melters and rollers of our plant and of the four plants competing with us ("Elektrostal", "Serp i molot "Zaporozhstal", and "Dnepr Aluminum Works") we shall fulfil and overfulfil the Socialist pledge made for

INNOVATORS OF THE "DNEPROSPETSSTAL"

The successes achieved by our plant are in many respects due to the creative work of innovators and inventors.

The scope of their work is best described by the number of innovations, over 4,300, put forward during the last six years.

Innovator team of the rolling department. From left to right: I.I. Kozachenko, F.P. Dragomiretsky, M.I. Kaplan, N.D. Zhekhovanov, M.S. Pasechnik, I.R. Troyan, V.I. Nemzer, I.F. Volkovitsky.

In 1956 alone 35% more suggestions were submitted than in the best pre-war year 1940, and during the four months of 1957 almost two and a half times more suggestions were utilized than in the whole of 1940.

The average yearly savings obtained by putting into effect the suggested innovations during the last six years amounted to 11,622 thousand rubles.

Innovators work on the mechanization and automation of production processes, on the increase of the output of production units, and on the perfection of production methods.

Most valuable suggestions are submitted by teams consisting entirely of innovators and inventors who solve extensive and complex technical problems exceeding, in the majority of cases, the capability of individual innovators.

Let us consider some proposals which have produced the greatest effects.

During the last two years extensive work was carried out on the reconstruction of electric furnaces, with the object of increasing their output. Earlier, the steel melters absorbed to a considerable extent the capacity reserves and exceeded the rated output of each furnace. In order to meet Socialist pledges, it was necessary to solve the problem of further increasing the production of electric steel with the existing equipment. It was in this direction that the teams of innovators and inventors concentrated their creative efforts.

The team of innovators led by engineer Yourkovsky planned and carried out the reconstruction of the 15-ton furnace of No. 1 melting shop, thus increasing its capacity to 20 tons. This work involved an increase of the diameter and height of the furnace casing and the shortening of the uprights and the crossbar; this enabled the lining of the hearth and walls to be extended in order to increase the working space and secured an increase of 4,200 tons in the yearly output of the furnace. The economic gain of this measure was 422,500 rubles per year.

Later this team, in cooperation with the team of Dmitrienko, reconstructed two 20-ton and two 30-ton furnaces and obtained a substantial increase of the charge (Fig. 1). This job was carried out during the general overhaul without additional breaks in the operation of the units. As a result of these modifications the steel melters produced 27.5 thousand tons of steel above the plan. The economic gain was a saving of 1.36 million rubles.

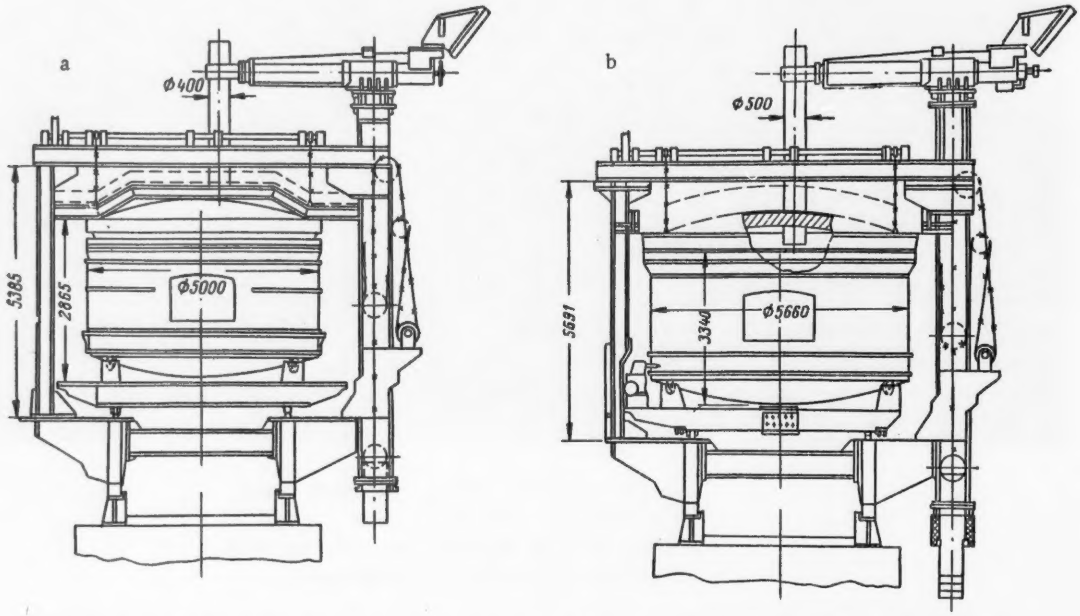


Fig. 1. General view of the 30-ton electric furnace. a) Before reconstruction; b) after reconstruction.

Another group of innovators, headed by engineer Shilko, planned and carried out the reconstruction of a 10-ton furnace. This involved a change in the charging method: instead of introducing the charge by means of a charging box through the working door, charging from a bucket through the furnace top was adopted; the charging time was cut to 5-6 minutes instead of the previous 20-25 minutes. This produced an additional yearly output of 1,000 tons of steel and a saving of 955 thousand rubles. Later, the capacity of this furnace was increased to 15 tons.

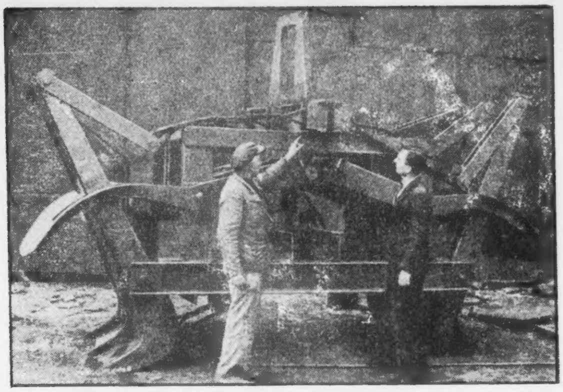


Fig. 2. Crane tool for breaking the lining of electric furnaces.
Left – the author of the design, comrade Yashchenko.

The gang of engineer Smetanin, consisting entirely of innovators, planned and carried out a rapid repair of a 40-ton furnace. The essence of this method is as follows. On a special platform beside the operating furnace, the framework of a similar furnace is assembled and its hearth rammed-in; then the old furnace is lifted from its foundation and carried away by cranes, and in its place the new assembly is fitted.

The application of this method reduced the duration of the repair from 9 to 4.7 24-hour days. This cut in the time of the repairs secured an additional yearly output of 950 tons of steel.

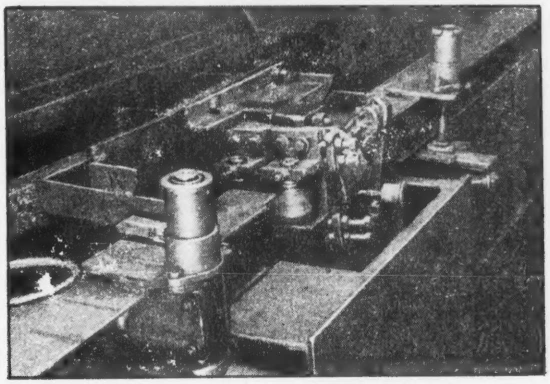
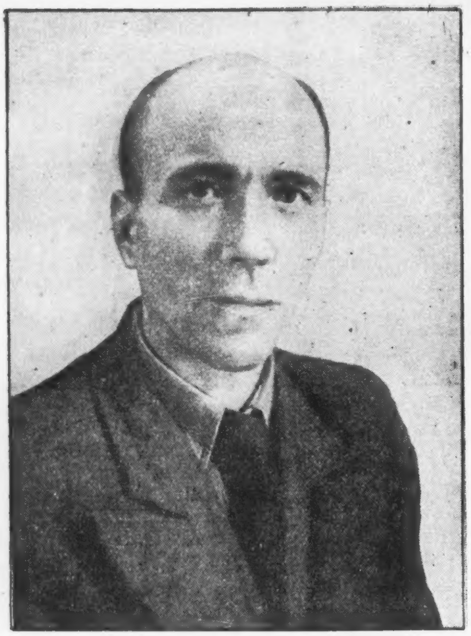


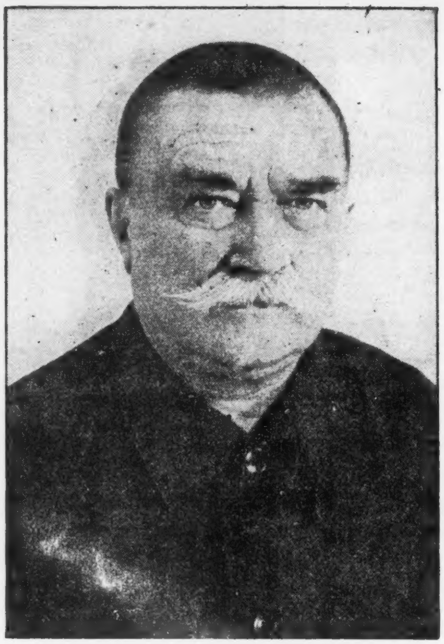
Fig. 3. Turning device of the 280 rolling mill.

A great contribution toward increasing the output of electric furnaces was made by inventor, former worker, comrade Yashchenko. He developed a very simple design of special tongs for breaking worn furnace lining during the cold repairs. This led to the mechanization of a process in which hitherto the operators had to break by hand the old furnace lining, working in a high temperature for several hours. The grab tongs made according to the suggestion of Yashchenko are mounted on the hook of an overhead crane, and having been introduced through the top into the interior of the furnace, break the old lining in 15-20 minutes. A considerable reduction in the duration of cold repairs of all electric furnaces was achieved by putting into effect this suggestion, the yearly economic effect amounted to a saving of 332,500 rubles. (Fig. 2).

A tremendous amount of work on the reconstruction and modernization of equipment was done by the inventors and innovators in the rolling shop.



Pit worker of the No. 2 melting shop, Fedor Mikhailovich Shavrovsky, fulfilled his scheduled output by 114.7% in the past year; for six months it was 118.2%.



Fedor Viktorovich Pirogov worked in the plant from its erection until 1957. In his final year the gang of the pouring pit of which he was the foreman achieved a yearly output of 113%. Even after retirement the old worker has not forgotten his plant. He is a member of the Council of Work Veterans at the plant.

The team of inventors and innovators which included welder Sverdlov, engineer Gavrilov, technician Krivonishchenko and others, proposed a modification of the welded part of the continuous heating furnaces of the 550 and 325 rolling mills.

The widening of welded parts of the furnaces, and the reduced gas consumption resulting from the reconstruction produced a yearly economy of 580 thousand rubles.

In the same shop the innovator team led by engineer Zhekhovanov carried out the reconstruction of the current supply circuit of the electric motor driving the 325 mill. The scheduled yearly saving due to the implementation of this suggestion amounts to 589,300 rubles.

As a result of modifications to the feed circuit of the drive motor of the 825 blooming mill, suggested by the innovator group of electricians, the average hourly output of the mill went up from 45.7 to 48.6 tons, and later, as a result of further improvements, to 52 tons.

The innovator team of engineer Nemzer replaced the guides and channels in the 280 light-section mill by a turning device and channels with drive rolls (Fig. 3), which they themselves designed. The reduction in waste and stoppages resulting from putting into effect these suggestions produced a scheduled saving of 129,800 rubles per annum.

The innovator team led by head of the department Lobarev carried out the mechanization of stands in the finishing group of the 325 light-section mill. The result was that the output of the mill was increased, the waste reduced, and some of the operators made available for other jobs.

All these suggestions are only a small part of the total contribution of innovators to the common objective of increasing the output and improving the productivity of labor.

THE WELFARE OF STEEL WORKERS

N. E. Klyuchikov

(Chairman of Trade Union Works Committee)

The Communist Party and the Soviet Government take care of the well-being of the working people. Vast funds are allocated to satisfy the increasing demands of the Soviet people for the comforts of life. This care is also enjoyed by our workers. Here are some figures.

At present, the total living accommodation of the works is about 80,000 m^2. This is 1.7 times more than in the pre-war year 1940. More than 12,000 employees and members of their families live in comfortable multi-story houses.

After the war 114 million rubles was spent on housing. Apart from dwelling houses two schools for a total of 1,850 pupils, three nurseries, two kindergartens, a pioneer camp, a children's summer home, a sports ground, a bathing place on the river Dnepr, a club, and a hospital with outpatient department were built. All this involved an expenditure of 19 million rubles. A further 22 million rubles were spent on communal building.

At present the construction of a prophylactic hospital on the island of Khortitsa is being completed. Here 85 patients will rest and receive treatment without interrupting their work.

In 1957 another 10,000 m^2 of living accommodation will be completed; this includes 2,000 m^2 built by private owners.

Since the war the plant supported the construction of over 300 private houses for their workers, foremen, and engineers.

We pay much attention to the problems of health and to the further increase in the cultural activities of employees. The trade-union committee alone spent millions of rubles for this purpose in the past five years.

About 2 million rubles were spent for the provision of free holidays in holiday homes. During the period from 1952 to 1956 every other employee has had a free holiday in a holiday home. Over a million rubles was spent on physical culture. During the last five years 3,830 children of employees spent some time in the pioneer camp.

In the works departments and hostels there are 25 "red corners". Over a thousand lectures were held and papers read there between 1952 and 1956.

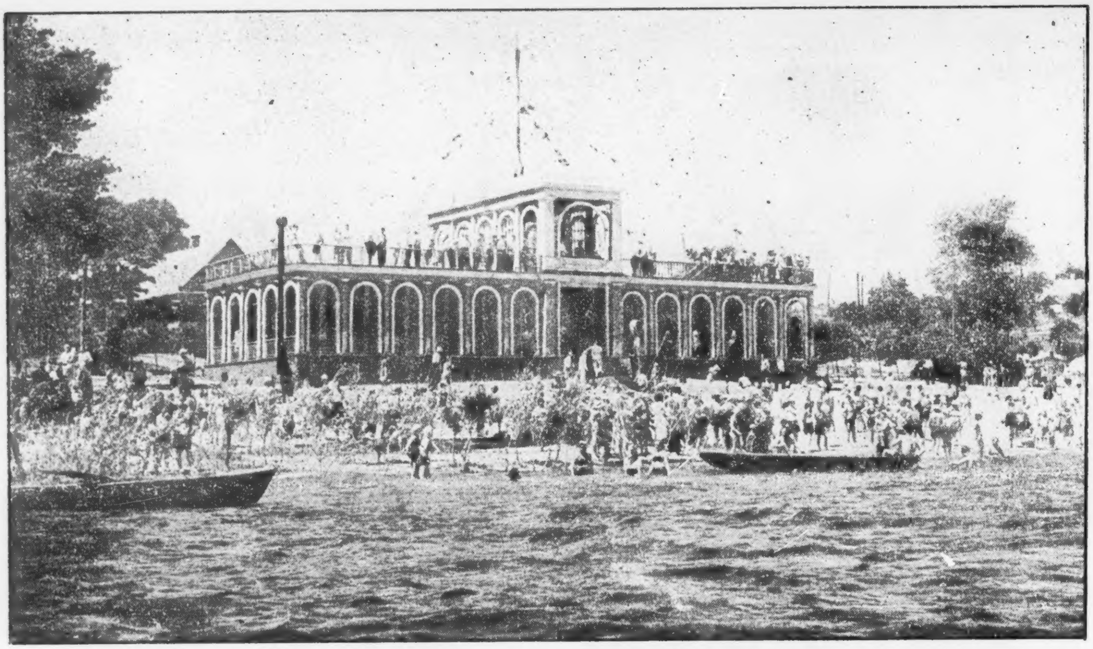
The works committee spent over 130 thousand rubles each year on the acquisition of equipment for the club, red corners, and sports grounds, and for the purchase of arts literature for the works library.

The number of people using the libraries grows from year to year. Mobile libraries serve the works departments and hostels.

Over 500 workers and engineers take part in numerous cultural activity groups in the club and red corners. Over 200 recitals were given by members of these groups.

Our best sportsmen, singers, dancers, and comedians regularly take part in all local, district, and regional shows and competitions.

More than 2,000 workers, foremen, engineers, and clerks take part in our cultural work.

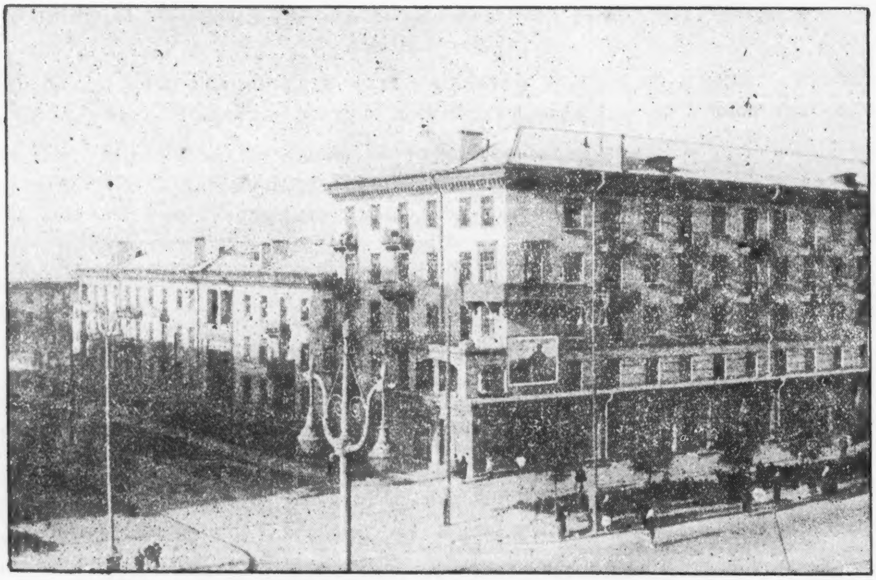


The Plant's bathing place on the River Dnepr.

Small and large scale excursions to historic places, to the coasts of the Black and Azov seas, and trips on the Dnepr are often organized at the plant.

Special evening functions are often held for young workers in order to enable them to meet experienced workers, to mix with soldiers of the Soviet Army and to see the Heroes of the Soviet Union.

This is how the workers of the "Dneprospetsstal" spend their leisure.



The Plant's living quarters on Stalin Street.

DIRECT REDUCTION OF IRON FROM ORE

V. F. Knyazev (TsNIIChM)

Until the appearance of the first blast furnaces in the 14th century, all iron was produced by direct reduction in the bloomery hearth. Ore and charcoal were charged in these hearths and air was fed. The iron was partially reduced, the unreduced oxides of iron fused together with the gangue contained in the ore and formed low melting slags. Individual grains of iron welded together to form lumps – blooms which were then withdrawn from the furnace and worked under hammers.

With the appearance of blast furnaces, iron began to be obtained in two stages–first pig iron in the blast furnaces, and then as steel in puddling furnaces, where the carbon in the pig iron was burnt out by the oxygen of the ferruginous slags.

The invention of the converter and open hearth methods of producing steel completely supplanted the uneconomic bloomery hearth process. The idea of the direct reduction of iron from ore, however, continued to interest research workers.

To obtain iron direct from ore, it is essential to solve two problems: to reduce iron without permitting it to become carburized to a great extent and contaminated with impurities and to separate the iron thus obtained from the gangue. At first sight, these problems do not appear to be difficult. Indeed, iron can be easily and rapidly reduced by gases (by carbon monoxide or hydrogen) or by solid reducing agents (coke, coal) at temperatures of the order of 1,000° C. The iron obtained by reduction from the gangue can be separated by magnetic separation or by smelting.

In solving these problems on an industrial scale, however, a number of difficulties arise. In gaseous reduction, the metal obtained is not contaminated but large volumes of gas containing much hydrogen and carbon monoxide are required. When ore is reduced by coke or coal, the iron obtained may be contaminated with ash, sulfur and phosphorus.

A high temperature is essential for the rapid evolution of the process of reduction. However, when the temperature is raised above 1000-1050° C (in some cases, higher than 800-900° C) the iron obtained by reduction sinters and adheres to the furnace walls, forming crusts. It is difficult to maintain a high temperature inside the furnace because, when the fuel is burned in the reaction chamber an oxidizing atmosphere is created while, with external heating, fuel efficiency is lowered, the furnace walls will become overheated and the formation of crusts is intensified.

The separation of the reduced iron from the gangue gives rise to many difficulties. In the case of magnetic separation after fine grinding, part of the iron is lost in the tailings. If the smelting method is used, the metal becomes carburized in the presence of a solid reducing agent.

Thus, for direct reduction of iron ore on an industrial scale, it is essential:

1. to use rich and pure ore and concentrates or to separate iron from the gangue if low grade ores are used;

2. to use pure and low ash types of solid fuel or gases with a high hydrogen or carbon monoxide content;

3. to create suitable temperature conditions;

4. to make the process continuous.

During the last hundred years, many methods of obtaining iron direct from ore have been suggested. Let us consider some of these.

Production of Sponge Iron in Crucibles (Hoganas Method)

The process was suggested by Suirin in 1911 and was first used in Hoganas (Sweden) from which it obtained its name.

High grade, powdery iron ore, concentrate or scale, is used for reduction. Coal is used as a reducing agent. The crucible, made of refractory material, is charged so that the ore is surrounded on all sides by the reducing agent (Fig. 1).

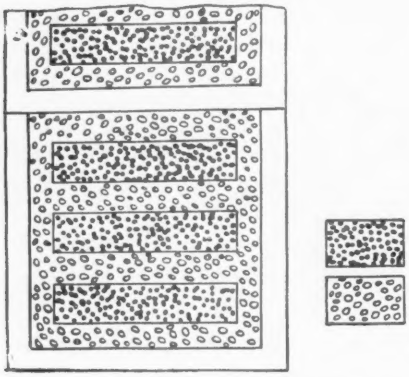


Fig. 1. Diagram showing the charging of the crucible in the Hoganas process of producing iron. a) Iron ore (or scale); b) mixture of coal and limestone.

So as to prevent the transfer of sulfur from the coal to the iron, the coal is mixed with limestone which absorbs the sulfur. The crucibles thus charged are transferred to the kiln (non-periodical action, annular or tunnel type) where they are heated to 1000-1100° C and held at this temperature for at least 50 to 60 hours.

The particles of metal undergoing reduction are fused or sintered together to form strong, porous briquets of sponge iron (Fig. 2). The iron thus obtained is cooled in the crucibles, is then extracted and the adhering reducing agent is removed.

A little oxygen and all the gangue still remain in the reduced iron. If the ore is pure, very pure iron free from admixtures is obtained. It is used for producing quality steels in open hearth and electric furnaces and also for making iron powder.

Sponge iron is obtained by this method in Sweden, Canada and other countries. In the U.S.S.R., a similar method is used to obtain sponge iron at the Sulin metallurgical plant.

Production of Sponge Iron in Rotary Furnaces

The main drawback in the Hoganas method is the long period of reduction, the low life of the crucibles and the difficulty of mechanizing the work.

Fig. 2. Sponge iron briquets (compared with a matchbox for size).

These defects are partly eliminated when iron is produced in rotary furnaces where a mixture of ore and the reducing agent (coal or coke breeze) are charged into a lined, cylindrical, inclined furnace at the discharge end of which is burned pulverized coal or gaseous fuel. When the furnace is rotated, the charge moves towards the discharge end and is heated, the iron then becoming reduced as in the crucible method but the process takes place much more rapidly – in 5 to 6 hours. In order to avoid adhesion of the metal and the formation of crusts in the furnace, the temperature is not allowed to exceed 1000–1100° C and the materials do not melt but remain friable. The end product is cooled in a cooling drum from which air is excluded. Then, the iron is separated from the remains of the reducing agent by magnetic separation. The gangue is not separated from the iron and, consequently, rich, lumpy ore is required for reduction. All the sulfur in the ore

is transferred to the iron. Part of the sulfur from the reducing agent also enters the iron.

This method of obtaining sponge iron was used at the Fushun plant in China where it was remelted to produce steel in electric furnaces. A similar method was also used to produce sponge iron required for non-ferrous metallurgy in April-May, 1956 at the Orsk-Khalilovo metallurgical combine.

When iron is produced in rotary furnaces, the furnace walls are heated to a higher temperature than the charge. In the pilot rotary furnace at the Domnarvet plant (Sweden), the air for combustion is fed through a pipe inside the furnace. In this way, combustion takes place at the surface of the charge consisting of ore and an excess of reducing agent.

Production of Sponge Iron in Shaft Furnaces

In 1932 at the Soderfors plant (Sweden), the proposed Wiborg plant was put into operation for the production of sponge iron.

This plant consists of a shaft furnace. High grade, lumpy ore or sinter is charged at the top (Fig. 3). Air is blown into the heating zone, the gases rising from the bottom are ignited and the ore is heated to 1000° C. In the zone of primary reduction, the heated ore is reduced by the gas to ferrous oxide. As the ore descends further, the ferrous oxide is reduced to metallic iron by the fresh reducing gas at a temperature of 950° C. This gas, consisting of carbon monoxide and hydrogen, is obtained in a special electro-carburetor to which is fed the partially used gas sucked from the furnace.

In the carburetor, the gas passes through a layer of charcoal or coke. It then passes through a sulfur absorber and is fed to the furnace. On the lower part of the furnace, the reduced iron is cooled and tapped.

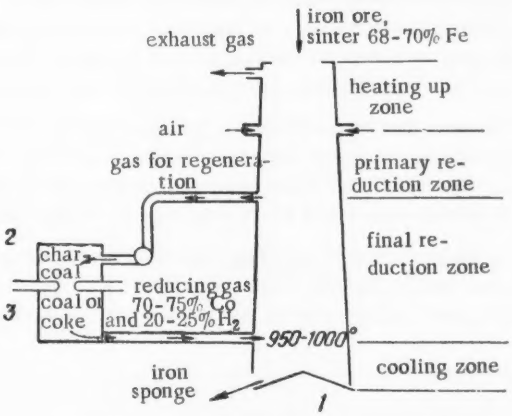


Fig. 3. Wiborg plant: 1) shaft furnace; 2) electro-carburetor; 3) electrodes.

Output per hour of the furnace, depending on size, is 30 to 50 tons. The sponge iron produced is used for the manufacture of quality steels.

Five such plants are operating in Sweden. They are well mechanized. The drawbacks of this method are the high consumption of electricity and the necessity of using strong, lump ore or sinter.

Production of Bloomery Iron in Rotary Furnaces (Renn Process)

In 1930, F. Johannsen (Germany) suggested a process for producing bloomery iron in rotary furnaces. In this process, a much higher temperature is used and the gangue of the ore is melted.

Fine ore and the reducing agent are mixed, fluxes (sand and limestone) are then added and the material is charged into a rotary furnace having a continuous operation. The length of the furnace is usually 60 m and the inside diameter 3.1 m. Beacuse of the inclination and rotation of the furnace, the charge moves to the discharge end where a gaseous or pulverized fuel is burned.

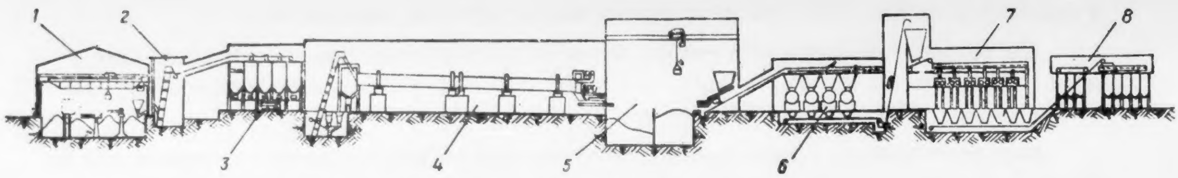


Fig. 4. Schematic section through the bloomery iron plant: 1) raw materials stockyard; 2) preparation department; 3) charging hoppers; 4) sand department; 5) stockyard for intermediate product; 6) ball mill section; 7) magnetic separation; 8) finished product stockyard.

As the charge moves through the furnace, the following processes necessarily occur: removal of moisture and volatiles from the charge and heating up of the charge; direct reduction of the oxides of iron by the carbon in the charge at a temperature of 700 to 1000° C; formation of slag (melting of the gangue and fluxes with the formation of viscous, doughy slags) and the formation of blooms (conglomeration and pelletizing of the reduced particles of iron) at 1250-1350° C.

Slag containing beads of metal of various sizes and the remains of the reducing agent is withdrawn from the furnace. The slag is cooled with water, crushed in ball mills, screened and subjected to magnetic separation; so emerges the finished product – blooms (Fig. 5), the intermediate product – fines – and the waste slag. In Czechoslovakia and Germany where the reducing agent contains much sulfur and the ore, much phosphorus, the blooms are resmelted in blast furnaces to produce basic converter and foundry iron. In this way, furnace productivity is increased and coke consumption decreased. In Japan and China during the Second World War, when purer burdens were used, the blooms were used for steel production in electric furnaces. The productivity of rotary refinery furnaces is usually 300 to 400 tons of ore or 60 to 100 tons of blooms per working day.

Drawbacks of the process are the poor lives obtained on the linings of the hot (refinery) zone, skulling of the furnace, and the difficulties in separating the metal from the slag (the metal may contain 5 to 20% of slag inclusions and impurities). The major part of the phosphorus and much of the sulfur in the charge pass into the bloom. A good deal of down time is suffered on account of the poor stability of the lining.

The advantage of the process is the possibility of utilizing reducing agents having poor physical properties (coal and coke fines) and low grade ores containing high silica gangues. The furnaces operate on acid slags (basicity from 0.1 to 0.3). In addition, the bloomery process is a flexible one for dealing with complex ores.

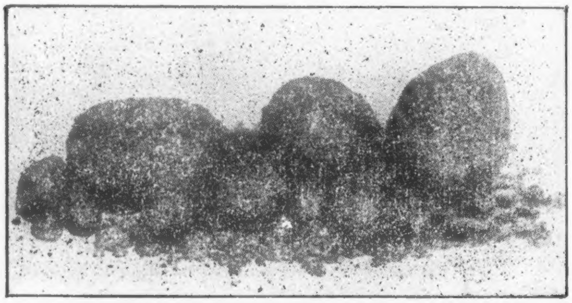


Fig. 5. Blooms obtained in the rotary furnace.

At present, the production of bloomery iron has been developed in Czechoslovakia, China, Korea and Germany. In our country, it is expedient to use the refinery process for the treatment of complex chrome-nickel iron ores of the Khalilovo deposits. In this way, we can produce an iron bloom alloyed with nickel for resmelting into steel. At the Orsk-Khalilóvo metallurgical combine, a production scale rotary furnace has been built and the production of iron-nickel blooms is being developed.

Every year, metallurgical plants smelt hundreds of millions of tons of iron ore; most of this is high-grade ore. In future, we shall encounter the problem of utilizing low-grade ores which require preliminary concentration. All existing methods of concentration are associated with crushing of the ore; in this connection, it is essential to find a means of effectively utilizing the fine concentrates. Ore fines can be used in the sinter burden to only a limited extent so that methods are at present being developed for pelletizing the fine concentrates. The treatment of such concentrates by the direct reduction method – in a fluidized bed or in a suspended state – is also of interest.

A reducing gas is blown through a bed of ore fines or concentrate. This causes the bed to become fluidized or boil like a liquid. At a certain gas velocity, the particles of material are separated from each other and each particle is "washed" by the gas – attaining a state of suspension. In this state and with a sufficiently high temperature, rapid reduction of the iron occurs. In order to use this method on a production scale, however, considerable difficulties have to be overcome. During the reduction process, particles of iron adhere to each other and become attached to the furnace walls, thus destroying the continuity of the process. The loss of iron particles is great.

Many countries are working on the problems of reducing ore in a fluid bed or in a state of suspension but these efforts have not yet progressed beyond the experimental stage.

MARKING OF BARS IN THE BLOOMING MILL

V. Ya. Sedush

Maintenance Engineer of the Blooming Shop at the Voroshilov Plant

For marking metal in the blooming mill we employ a Uralmashzavod marking machine (Fig. 1), which has resulted in the mechanization and automation of steel marking. It also improved the quality of work, and permitted the transfer of three markers to other work.

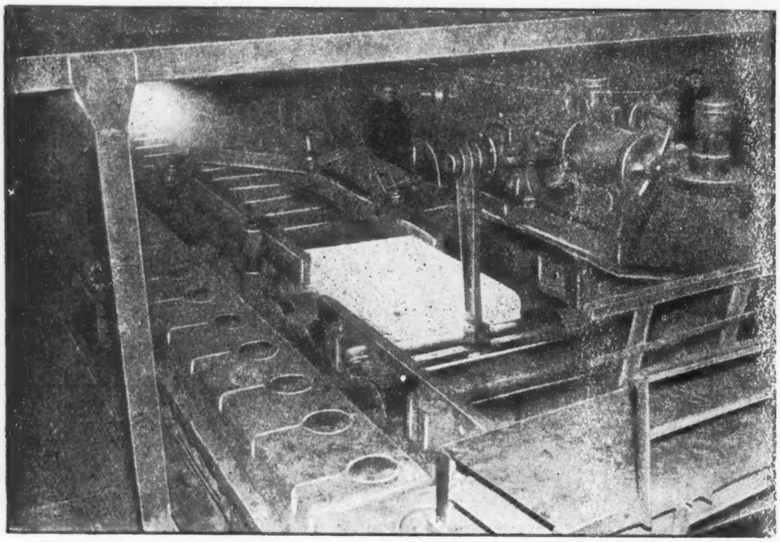
The machine works on compressed air at a pressure of 4.5-5 atmos.

The back-pressure before the working cylinder piston is 0.8-1atmos. This pressure is regulated by a pressure regulating device. The machine operates automatically and can produce up to 1,500 marks per hour in the end faces of blooms during their traversal of the mill table. Provision is also made for manual operation of the machine.

The machine consists of the marking mechanism incorporating pneumatic drive and the height adjustment device, which is operated by hand by means of a worm and screw mechanism.

The purpose of the arm lifting gear of the marking mechanism is to return the arm to its original position. It consists of a shaft carrying a pinion and a feeler (their movement on the shaft is restricted by keys), and a positively fixed arm carrying the type box.

The cylinder operates on the back-pressure principle. The mechanically operated air distributor connects the working cylinder with the atmosphere at the moment of marking, and with the pressure-air main for lifting the arm. It consists of the body, the distributor rod which carries the valves, and a spring. In the starting position one of the valves is closed and the air space of the working cylinder is connected with the atmosphere.



General view of the marking machine.

A locking mechanism is provided to retain the arm in the starting position. It has a cylinder with a piston, a rod, and a spring. In the starting position the rod is moved out and locks the arm.

As soon as the photocell reports the appearance of the front end of the bloom (or the universal hand switch is actuated) an impulse is sent to operate the solenoid valve (Fig. 2) of the locking mechanism.

This valve admits air from the main under the piston and the piston moves up the cylinder. Now the arm is released and hits the end of the bloom as it falls. After releasing the arm the rod of the locking device is returned to its original position by means of the spring.

During the fall of the arm the shaft of the arm lifting gear and the feeler are rotated, and the rod of the mechanical air distributor moves upward to connect the working cylinder to the main.

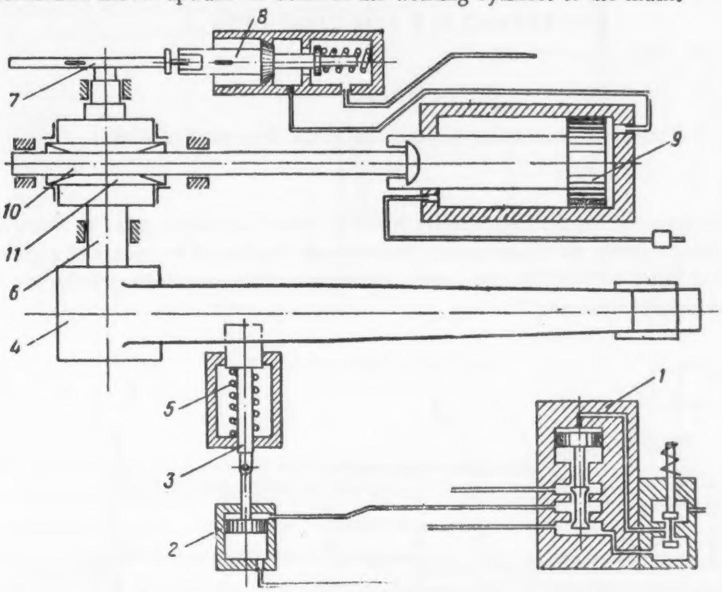


Fig. 2. Diagram showing the operation of the marking machine: 1) Solenoid valve; 2) locking device cylinder and piston; 3) rod; 4) arm with type box; 5) spring; 6) shaft; 7) feeler; 8) distributor rod; 9) piston; 10) rack; 11) pinion.

Air pressure moves the piston and rack into the rear position. At the same time the pinion of the transmission gear revolves anticlockwise and takes the shaft with the arm to the starting position. The locking device rod is moved backward by the arm. When the arm moves past the locking device, the spring moves the rod forward and locks the arm.

At the same time the feeler is also returned to its original position; the distributor rod returns downward and connects the rear space of the working cylinder with the atmosphere, causing the piston with rack and the pinion to withdraw into their original positions.

During the installation and operation of the machine some shortcomings were discovered. For example, the arm was not sufficiently strong and the shape of the feeler was incorrect. The type box very often fell apart, and the body of the mechanical air distributor frequently broke. The height adjustment device failed to meet requirements, as the adjustment needed too much time.

This called for the following alterations to the parts of the machine and individual components:

1)The cast arm of 35L steel was replaced by a forged design of 45KhN steel; the cross section of the arm near the shaft was increased; 2) the correct shape of the feeler was determined by experiment and its length increased to 200 mm; 3) the type box was made as a single forging; the securing spring was replaced by a bar 25 mm thick; 4) the body of the air distributor was made of steel instead of cast iron.

In future we intend to support the machine on four legs instead of two, as the present method of fixing requires replacement of the fixing bolts each month. An electric motor will be installed in order to achieve rapid height adjustment.

THE MECHANIZATION OF LABOR-CONSUMING OPERATIONS IN THE REPAIR OF REGENERATIVE SOAKING PITS

N. P. Borody

(Furnace Maintenance Department at the Dzerzhinsky Works)

When cleaning the checkers of the regenerative soaking pits of our plants, prior to 1956, the broken bricks, slag, and rubble were loaded inside the chamber into buckets and discharged by means of a grab crane into rail trucks. As this crane was often engaged in other work, buckets were discharged irregularly; the workers were often idle and their productivity was low.

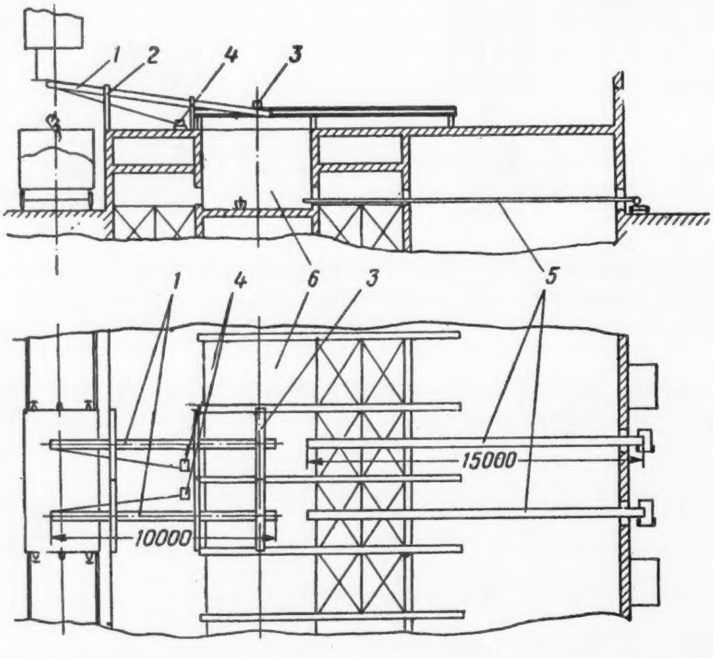


Fig. 1. Diagram showing the installation of single-rope hoists: 1) jib; 2) U-shaped supports; 3) crossbar; 4) hoist winches; 5) narrow belt conveyors; 6) checkers.

The new firebrick was prepared on the working platform and old brick recovered from the demolished regenerators was also loaded on to this platform. Then, if required, the brick was passed down an inclined wooden chute into the checker chamber to the bricklayers. As a result, the platform was overloaded, and this involved extra work in moving the brick.

At present the following simple and reliable procedure is followed for the removal of broken bricks and rubble from the soaking pit checker chambers when repairing the soaking pits. The loaded buckets are lifted from the chamber and discharged into the rail trucks by means of single-rope hoists. In order to provide for

uninterrupted work, tow buckets (Fig. 2) are carried by the single-rope hoist (Fig. 1).

The design of the hook trolley is given in Fig. 3.

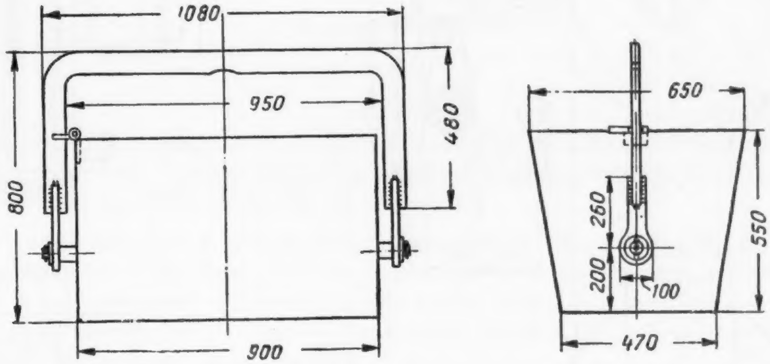


Fig. 2. Bucket of the single-rope hoist.

The single-rope hoist (Fig. 1) consists of the jib(1)bolted to the U-shaped supports(2). The jib is suspended by its rear part to the crossbar(3)(usually two railroad rails). The winches(4) are placed side by side so as to enable one operator to control both units. The bricks from the demolished regenerator, which can be used again, are removed by means of belt conveyors(5)and stacked; if they are needed the same conveyors carry them back to the checkers(6)together with new bricks. The mounting of conveyors presents no difficulties. The use of single-rope hoists and conveyors in the repair of soaking pit regenerator chambers made the work considerably easier and productivity was increased. The design of such hoists is simple and they can easily be made on the spot.

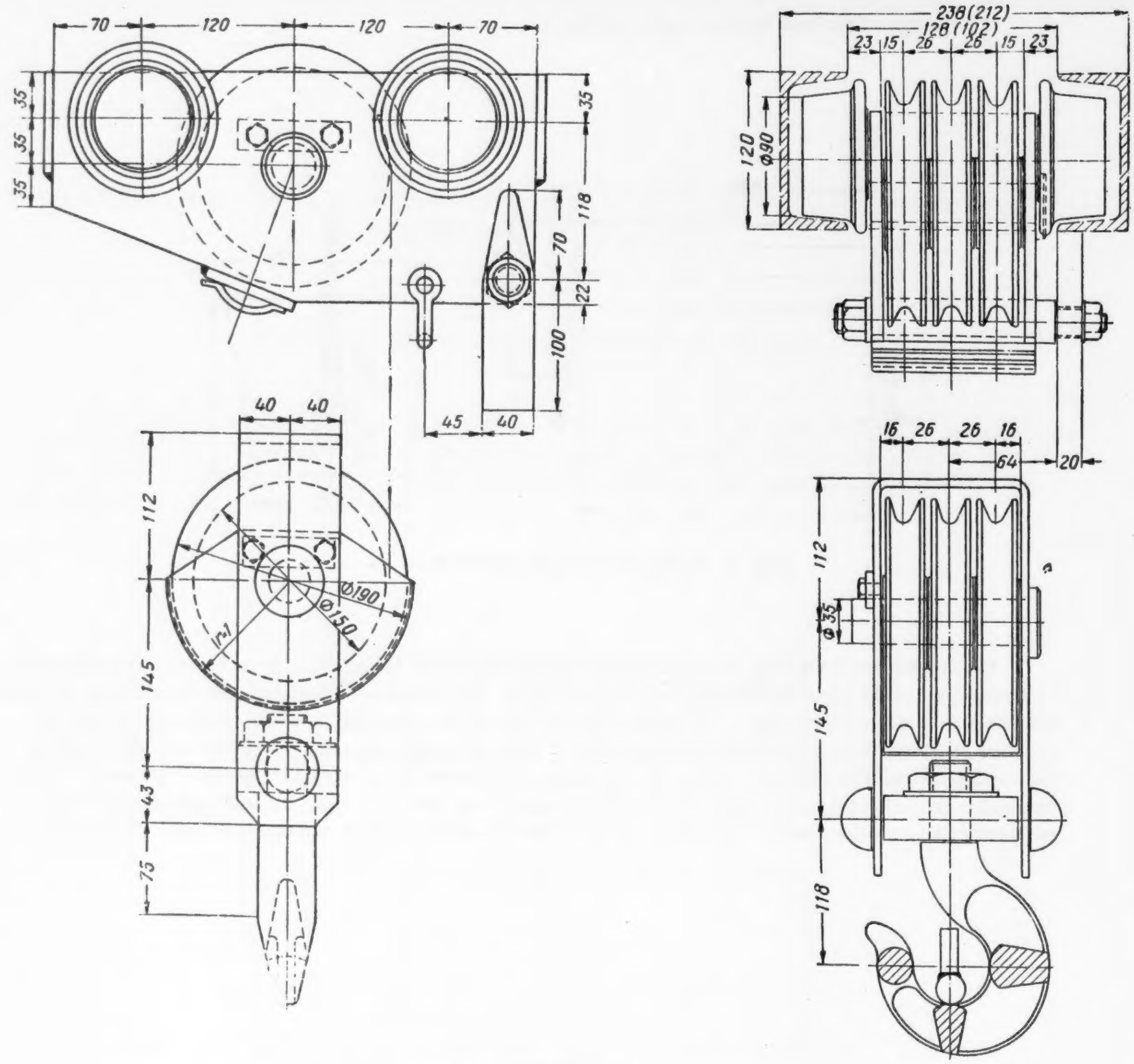


Fig. 3. Hook trolley.

OUTSTANDING METALLURGISTS

D. K. CHERNOV

The great Russian metallurgist Dimitry Konstantinovich Chernov was born on November 1st, 1839 in Saint Petersburg to the wife of a minor civil servant. In 1858 he graduated at the Institute of Technology and stayed at the Institute as a teacher of algebra and geometry.

This was at the time when the Russian Government, taught by bitter experience of the 1853-56 Crimean War (which revealed the backwardness of the Czarist army and the stagnation of industry), began to take much more interest in the development of the metal industry and, in particular, in the manufacture of steel guns. The famous Russian metallurgist P.M. Obukhov, the successor and pupil of P.P. Anosov, was commissioned to build a large gun and steel plant in St. Petersburg.

The plant was erected but the guns there manufactured often exploded at the first discharge. This created doubts as to the usefulness of the production of steel guns and even gave rise to discussions on the return to bronze and cast-iron artillery. The steel guns made by Krupp in Germany were of a somewhat better quality, but the method of their manufacture was guarded as a top secret.

In 1866 P.M. Obukhov engaged D.K. Chernov as an engineer and gave him the task of eliminating waste and achieving high-quality guns. It must be pointed out that in view of the means of laboratory investigations available at that time, this task was a very formidable one. But Chernov willingly tackled it. He spent days and nights at the plant studying the technology of steel manufacture, the properties of the metal, and the relation between the conditions in which ingots are worked and their quality characteristics. In 1867 a microscope was acquired for the plant and Chernov began to use it for research in steel.

In 1868 D. K. Chernov presented to the Russian Technological Society the paper "Critical Review of articles by Messrs Lavrov and Kalakutsky on steel guns and the investigations of D.K. Chernov on this subject." In this paper he established the phenomenon of polymorphism of iron, i. e. he proved that a changing temperature effects a change in the state of iron. Chernov pointed out that in the process of heating, after a certain temperature is reached, the properties of iron undergo a sudden change. For instance, iron heated to a temperature below a point a, which corresponds to a dark cherry red color cannot be hardened, however quickly it is cooled. On the contrary, says Chernov, it grows considerably softer and is easier to cut with a saw.

Steel heated to a temperature below a point b, which is characterized by a red color, does not change its structure after cooling. "But," pointed out D.K. Chernov," as soon as the temperature of steel has reached point b, the steel mass rapidly changes from a granular (or, generally speaking, crystalline) to an amorphous (wax-like) structure, which remains stable up to the melting point, i. e., to the point c." Considering this aspect in more detail, D.K. Chernov suggested that steel should be forged at a temperature above point b. This solved the problem of the strength of guns and large steel forgings.

One can only wonder how the young metallurgist was able to determine almost without any laboratory equipment, by the color of hot metal alone, the temperatures of the transition of iron from one phase to another.

The paper by Chernov was translated into French and English and published in many Russian and foreign journals. Later in the eighties and nineties Osmond and R. Austin, who used a thermo-electric pyrometer, conclusively proved the discoveries made by D.K. Chernov. At present the points discovered by D.K. Chernov form the basis of the theory of heat treatment of steel.

On November 23rd, 1868, Chernov presented another paper "Materials for the study of steel and steel guns" which was a supplement to his first paper. In March 1870, Chernov presented the paper "Microscopic

investigation of the structure of steel."

In February 1876, D.K. Chernov presented to the Russian Technological Society the paper "Material on the study of the Bessemer process," which contained a detailed study of this process. Apart from the description of the method, which for many years was known as the "Russian Bessemer process" and was tried out at the Obukhov and Nizhny-Tagil plants, the scientist gave in this paper his ideas on the use of oxygen in the converter process and also described the steel ladle stopper he had been using at the Obukhov plant.

The paper "Investigations concerning the structure of cast steel blocks" contained the investigation of the pouring process of steel into molds. It gave the theory of crystallization of the steel ingot. Chernov showed that steel is a crystalline matter; he described the structure and zones of the ingot and explained the mechanism of the formation of the shrinkage cavity and porosity, gas bubbles, internal stresses and the dendritic structure. This ingot theory, which has been brilliantly developed by Soviet metallurgists, is now generally accepted.

In 1880, D.K. Chernov left the Obukhov works because his relations with the director Admiral Kolokoltsev became strained. The admiral said that it was not the purpose of the works to support science and refused to expand research.

On his own initiative Chernov spent three years in prospecting salt deposits in the Donets area near Bakhmut (now Artemovsk). This prospecting was crowned with success. From 1884 Chernov worked at the Ministry of Communications as the Chief Inspector on orders awarded to the steel industry. At the same time he was a member of the Naval Learned Committee at the Naval Ministry. At this time he wrote a number of papers of which the "Generalization of some observations on the working of steel" and "On the manufacture of steel for armor-piercing shells" are the most remarkable.

In 1889, Chernov accepted the Chair of Metallurgy and Steel Manufacture at the Mikhailovskaya Artillery Academy. He held this post for thirty years. Papers written by Chernov during this period such as "On the burning of steel gun bores", and a number of others, brought him world fame. In his lectures on the manufacture of steel Chernov put forward a systematic theory on the heat treatment, and the formation of physical and mechanical properties of steel. The assumption of D.K. Chernov on the grouping of atoms in hardened and tempered steel was later proved by x-ray investigations. He did not ignore the problem of damask steel. He was able to explain the amazing properties of this steel and the cause of its pattern and showed how it is possible to obtain patterns of any shape on damask steel.

The paper by Chernov "On the direct manufacture of iron and steel in the blast furnace", published in this period, deserves attention. In this work he suggested a furnace of original design representing a combination of shaft and regenerative furnace. His work "On the crystals of diamond and carborundum in steel" (1907) is of interest as he considers in it the shape of carbon crystals formed in steel. After the investigation of this question Chernov pointed out that diamonds are not crystals of magmatic origin but are formed as a result of a prolonged relatively cold reaction taking place in the rock.

It should not be assumed that D.K. Chernov was an expert only in the narrow field of metallurgy. His talent was too great to be confined to one subject only. In the eighties Chernov completed a work "On the coming possibility of mechanical flight without the use of a balloon", and in December 1893 he presented in the Aeronautical Section of the Russian Technological Society a paper containing a design of a helicopter.

D.K. Chernov passionately loved to play the violin. He made violins and other bowed string instruments himself. His violins were able to compete with those made by the old Italian masters. Even the most experienced musicians were unable to tell whether a violinist was playing on an Italian violin or on an instrument made by Chernov.

In 1916, the 76-year-old scientist went to the Crimea for treatment after a serious illness. In the spring of 1917 he returned to Petrograd, but was again taken ill and in September left for Yalta, where he intended to remain until the winter. But, as in 1918 the Crimea was cut off from the rest of Russia, Chernov was unable to return. He lived in extremely difficult financial circumstances, but continued his work; he gave lectures at the Yalta Technical College and presented papers on scientific and technological subjects.

In March 1920, he gave a lecture entitled "The impossible", which was devoted to the so-called insoluble mathematical problems: the division of an angle into three parts, the determination of the length of a circle, and the quadrature of the circle. Chernov proposed a very original solution of these problems.

The forces of General Vrangel and the interventionists who occupied the Crimea gave no financial assistance to Chernov. Before they fled from the Crimea, the British Government invited Chernov to England and even sent a special destroyer to collect him. But the scientist-patriot refused to leave the country of his birth.

The position of the scientist and his family improved only after the Crimea was liberated.

But three years of hard life broke the strong man and he died in the night of January 2nd, 1921, at the age of 82.

Soviet and foreign scientists often make use of the work of Chernov. His theory on the crystallization and heat treatment of steel has been recognized throughout the world and occupies an honorable place in the treasure chest of world science.

METALLURGIST IN ENGLISH TRANSLATION

October, 1957

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SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosenergoizdat	State Power Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LEIIZhT	Leningrad Power Inst. of Railroad Engineering
LET	Leningrad Elec. Engr. School
LETI	Leningrad Electrotechnical Inst.
LETIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MEP	Ministry of Electrical Industry
MES	Ministry of Electrical Power Plants
MESEP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTI	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOE	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIEL	Central Scientific Research Elec. Engr. Lab.
TsNIEL-MES	Central Scientific Research Elec. Engr. Lab.—Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIESKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZEI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us. — Publisher.